BMP RETROFIT PILOT PROGRAM

BASIS OF DESIGN REPORT
TREATMENT UNITS DESIGN
DISTRICT 7 PROCUREMENT

CALTRANS REPORT ID #: CTSW-RT-98-68-D1

AUGUST 1998

Prepared for:

CALIFORNIA DEPARTMENT OF TRANSPORTATION
SACRAMENTO, CALIFORNIA

Prepared by:

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ACRONYMS

ac	Acre
acft	Acre feet
BMP	Best Management Practice
Caltrans	California Department of Transportation
cfs	cubic feet per second
gpm	gallons per minute
NRDC	National Resources Defense Council

1.0 INTRODUCTION

1.1 General (Purpose & Scope)

Pursuant to the Caltrans Consent Decree, a BMP Retrofit Pilot Program is required to investigate the constituent removal efficiency, technical feasibility and costs of retrofitting Caltrans facilities with selected Best Management Practices (BMPs). This report documents the design parameters associated with implementation of Best Management Practices for storm water discharges from eight Caltrans District 7 facilities. These facilities include four Caltrans Maintenance Stations and four Park and Ride Facilities. Siting information for each of these locations is provided in the report entitled "Scoping Study, Retrofit Pilot Program, Caltrans District 7", dated April 28, 1998 by Robert Bein, William Frost & Associates (RBF). The BMP Pilot Projects discussed in this report are four sand media filters, three multi-chambered treatment trains (MCTT), and one oil/water separator.

1.2 Objectives

The purpose of this study is to provide design criteria in support of the construction drawings of the BMP Retrofit Pilot Program projects. Specifically, the objectives of this report are as follows:

- Define hydrologic criteria for the design of the BMPs.
- Develop discharges for the design conditions above.
- Define hydraulic criteria for the design of the BMPs.
- Define design parameters for each BMP.
- Provide technical calculations supporting the drainage facility designs shown on the construction drawings.

1.3 Project Locations

There are eight sites that are located in different cities. A list of all these sites is provided below.

- Alameda Maintenance Station, 1740 East 15th Street, Los Angeles
- East Regional Maintenance Station, 1940 S. Workman Mill Road, Whittier
- Metro Maintenance Station, 2187 Riverside Drive, Los Angeles
- Foothill Maintenance Station, 850 East Huntington Drive, Monrovia
- Termination Park and Ride, I-105/I-605 Intersection, Norwalk

- Via Verde Park and Ride, Intersection of Via Verde and San Dimas Rd., San Dimas
- Paxton Park and Ride, I-210/Paxton Intersection, San Fernando
- Lakewood Boulevard Park and Ride, I-105/SR19 Intersection, Downey

1.4 Construction Drawings, Figures

Construction drawings of the media-filters, multi-chamber treatment trains and oil/water separator are shown on Drawings D-1 through D-8, and are included in Appendix A. Photographs of the project sites are included in Appendix B as Figures 1 through 8.

1.5 Calculations

Calculations supporting the drainage facility designs shown on the construction drawings are included in Appendix C.

1.6 Construction Costs

The construction cost received in a July bid for the eight sites is $2,712,769. A construction cost breakdown is included in Appendix D.

2.0 HYDROLOGIC CHARACTERISTICS

2.1 Rainfall Characteristics

The amount of rainfall from a 1 year, 24 hour storm was estimated in order to calculate storm water runoff for designing the detention basins. To develop rainfall values for the study area, Brown and Caldwell analyzed precipitation records (24-hour rainfall totals) for the Los Angeles International Airport (LAX) weather station from 1944 to 1995. Analysis was performed using the log-Pearson type III method and by the annual series data method. As a comparison to the LAX rainfall data, a second and third set of rainfall records were analyzed, using only an annual series data method, from the Van Nuys and the downtown Los Angeles weather stations. Both of these stations are located in the same rainfall region (coastal plain), as defined by the Los Angeles Department of Public Works (LACDPW), as the station at the LAX airport.

From the analysis, at the LAX weather station, the calculated 24-hour rainfall total for a one-year storm frequency event equaled 0.5-inches (log-Pearson) and 1.12-inches (annual series data method). The log-Pearson analysis was heavily influenced by two extreme drought years. The results for the Van Nuys and downtown Los Angeles stations were 0.71 and 0.73-inches respectively using the annual series data method. Because of the uncertainty of the exact size of a one-year frequency storm, a 1.0-inch value was chosen to represent the amount of rainfall for a one-year, 24-hour storm within the Los Angeles Coastal Plain (Caltrans Zone K and L). Because of the uncertainty of the method in the one-year analysis, a one-inch storm corresponds to about 1.2 year storm using the LAX weather station data and the log-Pearson analysis method. A rainfall zone map showing the extent of the rainfall zones within Caltrans District 7 is included in Appendix C.

2.2 Soil Types and Infiltration

Soils at all eight sites have been previously disturbed, graded and compacted during the construction of the park and ride or maintenance station facilities. Soil types range from clayey sand to silty sand and coarse sand at different sites. Ground water was encountered only at two sites (Lakewood and Metro maintenance Station). Cobbles were found at the Paxton and Foothill sites. Preliminary soils report and design data is included in Appendix E.

2.3 Methodology and Procedure

Design Storm Water Runoff Volume. The areas within the Caltrans boundary around the eight facilities were determined. The total runoff volume for the 1-year, 24 hour storm was then calculated using the following assumptions (per Appendix D of the "California Storm Water Best Management Practice Handbook, Municipal."):

- 0.06-inches of rainfall captured in local depressions,
- Runoff coefficient of 0.9 for impervious surfaces,
- Runoff coefficient of 0.15 for pervious surfaces.

Calculations for the design of storm water runoff volume are included in Appendix B.

Peak Storm Water Flow Rate. The modified Rational Method was used to develop the peak storm water flow rate to the basins. This is the same method used in the Caltrans District 7 Hydraulics Manual, which is based upon the Los Angeles Department of Public Works (DPW) method. DPW is responsible for providing flood control protection in Los Angeles County.

The design storm rainfall intensity values were determined by evaluating average intensity duration curves from the District 7 Hydraulics Manual. Although the peak intensity is only available for a 10-year, 25-year, and 50-year storms, a conversion curve is available to convert a 50-year storm intensity to a one-year storm. The conversion curve, from the District 7 Hydraulics Manual, page III-038, was used to convert the 50-year peak intensity values to the 1-year, 24-hour design storm by multiplying the 50-year rainfall intensity value by 0.445 (this conversion value is provided on the curve). The peak storm water flow rate was then calculated by multiplying the peak rainfall intensity value in inches/hour by the total impervious drainage area, and then converting to gallons per minute (gpm).

A duration of peak rainfall equal to the time of concentration was used to determine peak rainfall from the curves. Concentration time 10 minutes was used.

Peak Rainfall Intensity was taken as 1.47 for all sites except Foothill Maintenance Station and Via Verde Park and Ride where Peak Rainfall Intensity was considered as 1.67

Calculations for peak storm water flow rates, including copies of the 50-year Average Intensity Duration Curve and the Conversion Curve are included in Appendix C.

2.4 Discussion of Individual Sites

Runoff at each site was collected from as much of the site as practical. The following discussion describes the tributary area at each site. Figures showing the drainage of each site is included in Appendix F.

Alameda Maintenance Station. The oil/water separator has been located to collect flow from about one-third of the site. This portion of the site includes the area in front of the main building where trucks and other vehicles park. The oil/water separator has been located so that the entire system can flow by gravity without pumping. This eliminated costs for pumps, pump sump, and reduced cost for electrical power supply and maintenance of such facilities. Due to the location and elevation of the oil-water separator, no other runoff can be diverted to it.

Eastern Regional Maintenance Station. The site is graded to flow to the west and the south. Most of the runoff at the site is collected in a Vee-gutter located in front of the main building on site. The media filter has been located to intercept flow from this gutter. As designed the media filter treats about 80 percent of the site runoff. A large portion of the remaining portion of the site is an unpaved area for equipment storage.

Foothill Maintenance Station. The existing site is graded to flow from north to south with runoff collected in a series of drainage inlets. The filter will treat runoff draining to a separate southern drain inlet. The tributary area includes the fueling area, parking, and general maintenance areas. The northern inlets will be used for other pilot BMPs (catch basin inserts) and therefore their additional tributary areas are not available for treatment by the media filter.

Termination Park and Ride. The site drains from north to south with runoff collected in three Vee-gutters. The media filter is located to treat flow from the center gutter, which receives runoff from about one-third of the entire site. Flow could have been collected from the rest of the site with an additional increase in size and depth of the unit. However, it was decided that the proposed design is representative of the site and could be implemented with the least disruption to the Park and Ride facility.

Paxton Park and Ride. About 95 % of the site drains to a single drain inlet at the west corner of the site. Runoff is diverted from this drain inlet to the media filter. A trench drain is provided to capture runoff that would normally exit the site to the street through the site access driveway.

Via Verde Park and Ride. The entire site drains to a single drain inlet at the west corner of the site. Runoff is diverted from this drain inlet to the MCTT unit.

Metro Maintenance Station. Runoff from the existing site flows to the west where it is collected in a drainage ditch along the edge of the site. Runoff from this collection ditch is diverted into the MCTT unit, allowing flow from almost all of the site to be treated.

I-105/Lakewood Park and Ride. Almost all of the runoff from the paved portion of the facility drains to a drain inlet located along the south east portion of the site. Runoff from this drain inlet is diverted into the MCTT. Only runoff from a small portion of the site that flows offsite through the access driveway is not captured for treatment.

2.5 Summary of Results

A summary of the parameters used and the storm water runoff volume and peak storm water flow rates are presented in Appendix C.

3.0 DESIGN DISCUSSION

3.1 Design Criteria

In order to maximize the effectiveness of the treatment units to protect water quality, various design criteria were used including detention time, water depth, and drainage area, type of runoff that resulted in three different types of treatment units namely Media Filters, MCTTs, and Oil/Water Separator. These are discussed below.

3.2 Media Filter Design

The primary function of the treatment units is to provide removal of particulate pollutants from storm water runoff. In addition, heavy metals and other toxic chemicals that will attach to particulate matter will also be removed.

Recommended design criteria per the Scoping Study include a detention time of 24 hours for average conditions.

Basic Set-up. The media filter setup consists of:

- Drainage inlet unit,
- Sedimentation basin,
- Filtration basins,
- Sump for the collection of filtered runoff
- Provision for overflow bypass
- Flow measuring devices and samplers at both inlet and outlet

Major components and their designs are discussed briefly.

3.2.1 Drainage Inlet Unit

The inlet drainage units are designed to capture the runoff from the facility. Some sites have been provided with open trench inlet that carry the intercepted flow to the Drainage Inlet Unit. At other sites the Drainage Inlet Units are connected to the existing catch basins.

3.2.2 Sedimentation Basin

The removal of discrete particles by gravity settling is primarily a function of surface loading. Basin depth is of secondary importance as settling is inhibited only when basin depths are too shallow. The particles selected for complete removal in the sedimentation basin are those which are greater than or equal in size to silt with the following characteristics:

- particle diameter 0.0007 foot (20 microns) and
- specific gravity of 2.65.

Surface Area of Sedimentation Basin. The surface areas of the sedimentation basins were calculated by dividing the total volume of runoff in 24-hr period by the depth of the sedimentation basin. The minimum depth of the sedimentation basin was arbitrarily chosen as 7ft (2.13 m). This allows the Sedimentation Basin to store the entire volume of runoff of a 1 year, 24–hr storm.

Outlet Pipe. The outlet pipe conveys the water quality volume from the sedimentation basin to the filtration basin. The outlet structure is designed to provide for a minimum draw-down time of 24 hours. A 6-inch diameter PVC standard pipe with perforations to achieve required draw down time is installed in the sedimentation basin wall. The water is conveyed to the filtration basin through the perforations.

Basin Geometry. The length to width ratio of basin was kept as nearly as possible to 2:1 in order to maintain a smooth flow regime and avoid short circuiting. However, short circuiting is not a significant problem because the flow out of the sedimentation basin will generally be less than the flow into the basin. Energy will be dissipated as it enters the pool of water in the sedimentation basin.

3.2.3 Filtration Basin

For filtration basins, surface area is the primary design parameter. The required surface area is a function of sand permeability, bed depth, hydraulic head and sediment loading. A filtration rate of 0.0545 gallons per minute per square foot (10.5 feet per day or 3.4 million gallons per acre per day) has been selected according to the Austin filter design guidelines. This filtration rate is based on Darcy's Law coefficient of permeability of 3.5 feet per day, an average hydraulic head of three (3) feet and a sand bed depth of 18 inches. The minimum surface area required for filtration basin was calculated using the following equation:

$$A_f = A_D H/18$$

Where

A_f	is the minimum surface area of the filtration basin in acres
A_D	is the contributing drainage area in acres
H	is the runoff depth in feet (1.0 inch = 0.0833 feet).

Inlet Structure. The outlet structure described in the sedimentation basin is the inlet structure for the filtration basin. As flow enters the filter chamber it flows over a weir to distribute the flow evenly across the filter and reduce scouring.

Sand Bed. The top layer is a minimum of 18 inches of 0.02 – 0.04 inch diameter sand. Under the sand is a layer of 1/2-inch to 2-inch diameter gravel which provides a minimum of two inches of cover over the top of the under drain lateral pipes. The sand and gravel layers are separated by a layer of geotextile fabric.

Underdrain Piping. The underdrain piping consists of main collector pipe and perforated lateral branch pipes. The main collector pipe has an internal diameter of 6-inches. The internal diameters of lateral branch pipes is minimum 4-inches or greater. Perforations are minimum 1/2 -inch on both sides of the pipe and are at 6-inch intervals along the length. All piping is schedule 40 PVC. Maximum grade of piping is kept at 1 percent slope.

3.2.4 Sump for Collection of Filtered Runoff

A sump for collection of filtered water is provided at each treatment unit. The water is discharged from the sump to the existing drains using a sump pump which is activated based on water level in the sump. Each sump pump is specified according to the flow at a particular treatment unit. The pumps generally discharge to the original storm drain or storm channel.

Initially it was thought that flow through the media filter might be able to occur completely by gravity, but this was not possible due to the minimal slope at the site, and the need to discharge to the existing storm drainage system.

3.2.5 Provision for Overflow Bypass

An overflow provision is provided at each site. The units are in the drainage path, therefore excess flow automatically bypasses the treatment unit and drains to an existing discharge point.

3.2.6 Flow Measuring Devices and Samplers

A straight length of pipe is provided to accommodate any flow measuring devices and samplers that may be required at the site. A concrete housekeeping pad is provided for mounting of the flow measuring and sampling equipment.

3.3 Oil/Water Separator

The commercial oil/water separator is being constructed at the Alameda Maintenance Station. The peak flow at the station is 474 gpm. The selected oil/water separator has a peak flow capacity of 500 gpm.

Other design considerations include:

Reynolds Number <2000 (laminar flow)
Designed in accordance with Stokes Law
Designed in accordance with API 421 (Design and Operation of Oil/Water Separators)

Vendor information and other details are provided in Appendix G.

3.4 Multi-Chamber Treatment Units

The Multi-Chamber Treatment Train (MCTT) is a process unit which has been designed to maximize pollutant removal, and is documented in *Stormwater Treatment At Critical Areas, Vol. 1: The Multi-Chambered Treatment Train (MCTT)* (Robert Pitt, et.al. issued by National Risk Management research Laboratory, U.S. EPA, October 1997). The MCTT designs were reviewed by Robert Pitt and his suggestions incorporated where possible (see Appendix H).

The MCTT includes a catch basin/grit chamber followed by a two-chambered tank that is intended to reduce a broad range of toxicants. The runoff enters the catch basin chamber by passing over a flash aerator (small column packing balls) to remove highly volatile air components, if present, and to capture large debris. This catch basin also serves as a grit chamber to remove the largest particles. The second chamber serves as an enhanced settling chamber to remove smaller particles and has inclined tube settlers to enhance sedimentation. This chamber also contains sorbent pads to further enhance the removal of floatable hydrocarbons and additional volatile compounds. The water is then transferred to the final chamber containing a mixed media slow filter, with a filter fabric top layer. The MCTT is sized to totally contain all of the runoff from a 0.4 inch rainfall event.

3.4.1 Catchbasin Inlet Chamber

The catchbasin is effective in removing coarser runoff solids. The dimensions of the catch basin are as identified in the Scoping Study.

3.4.2 Main Settling Chamber

The main settling chamber uses a hydraulic loading rate (depth to time ratio) for removal estimates. This loading rate is equivalent to the conventional surface overflow rate (SOR), or upflow velocity for continuous–flow systems, or the ratio of water depth to detention time for static systems. The required runoff depth storage capacity increases as the depth of the main settling chamber increases. The settling depth for all the MCTT sites was selected as 8 feet (5 feet of storage plus 3 feet of tube settlers and distribution plenum).

Water is pumped from the main settling chamber to the filter chamber. Early designs included gravity flow from the settling chamber to the filter chamber, but this caused the filter chamber to be extremely deep. The extreme depth would make construction difficult, increase wall thicknesses, and in some cases encountering groundwater was a possibility. To reduce construction costs, intermediate pumping was added. This has the added benefit of being able to more easily control the holding time of the storm water in the settling chamber.

3.4.3 Filter Chamber

The final MCTT chamber is a mixed media filter device. It receives water which has been partially treated by the grit and the main settling chambers. The media is a 50/50 mix of sand and peat moss which has been found to be good at removing metals with minimal detrimental effects. The filter bed consists of 18 inches of media over drain gravel. A geotextile fabric is placed on top of the media to provide better distribution of liquid and eliminate scouring. The fabric is also placed between the media and the gravel to minimize the migration of media into the gravel. Perforated PVC pipe is located in the gravel layer to collect water and transport it to a sump.

3.4.4 Effluent Sump

A sump and pump is provided at each filter to collect the filtered water and lift the liquid to the existing site storm drainage system. The sump pump is sized based on the range of flows expected at each site. The pump is activated based on the water level in the sump.

3.4.5 Input Values and Assumptions

Water is pumped from the settling chamber to the filter. Runoff is held for 24 hours before pumping is started.

The selected pollutant removal goal is 90 percent. The assumed TSS concentration in influent is about 100 mg/l with the assumed TSS concentration after pre-settling being 50 mg/l. The filter solids loading rate (based on the peat/sand mixture) is 5000g SS/sq. meter per year.

3.4.6 Summary of MCTT Sizes

Site	Storage Capacity, cf	Sedimentation, Surface Area, sf	Filtration Surface Area, sf
Via Verde	1780	365	188
Metro Maint. Station	7480	1515	755
Lakewood Park and Ride	3150	645	340

REFERENCES

Robert Bein, William Frost and Associates, April 28, 1998. *Scoping Study, Retrofit Pilot Program, Caltrans District 7.*

California Department of Transportation. As-built drainage system drawings.

California Department of Transportation, District 7, 1985. *Hydraulic Design and Procedures Manual*. Ed. by Herman and Polimeni.

Camp Dresser and McKee Inc., et al, March 1993. *California Storm Water Best Management Practice Handbook, Municipal.*

Camp Dresser and McKee Inc., September 1997. *Caltrans Storm Water Quality Handbook, Planning and Design Staff Guide.*

The L.K.R. Group, March 20, 1998. *Revised Pre-Construction Geotechnical Evaluation Report, Caltrans Storm Water Runoff Study Retrofit Facilities, District 7, Los Angeles County, California.*

Robert Pitt, et al, Dept of Civil Engineering, The University of Alabama at Birmingham. October 1997. *Stormwater Treatment at Critical Areas; Vol1: The Multi-Chamber Treatment Train (MCTT)*

APPENDIX A

DESIGN PLAN DRAWINGS

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET No	TOTAL SHEETS
7	LA	VAR	VAR	1	43

INDEX OF SHEETS

STATE OF CALIFORNIA

DEPARTMENT OF TRANSPORTATION

PROJECT PLANS FOR CONSTRUCTION ADJACENT TO

STATE HIGHWAY

IN LOS ANGELES COUNTY
AT VARIOUS LOCATIONS

To be supplemented by Standard Plans dated July, 1997

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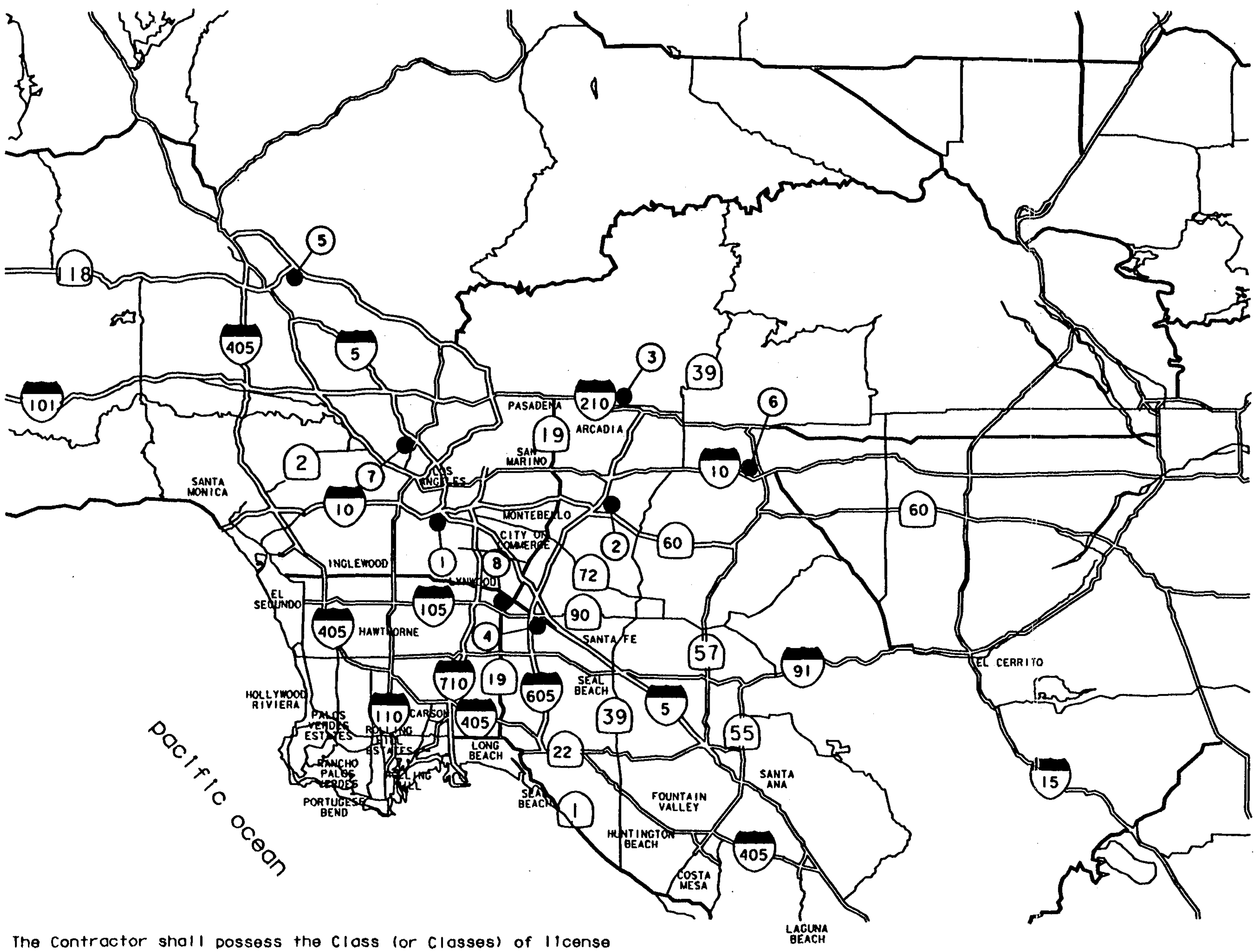


LOCATION OF CONSTRUCTION

LOC	ROUTE	DESCRIPTION
1	10	ALAMEDA MAINTENANCE STATION
2	60	EASTERN REGIONAL MAINTENANCE YARD
3	210	FOOTHILL MAINTENANCE STATION
4	105	TERMINATION PARK AND RIDE
5	210	PAXTON PARK AND RIDE
6	210	VIA VERDE PARK AND RIDE
7	5	METRO MAINTENANCE STATION
8	105	LAKEWOOD PARK AND RIDE

Project Engineer Date
Registered Civil Engineer

REGISTERED PROFESSIONAL ENGINEER
DOUGLAS B. ROBISON
No. 37109
Exp. 06-30-00
CIVIL
STATE OF CALIFORNIA

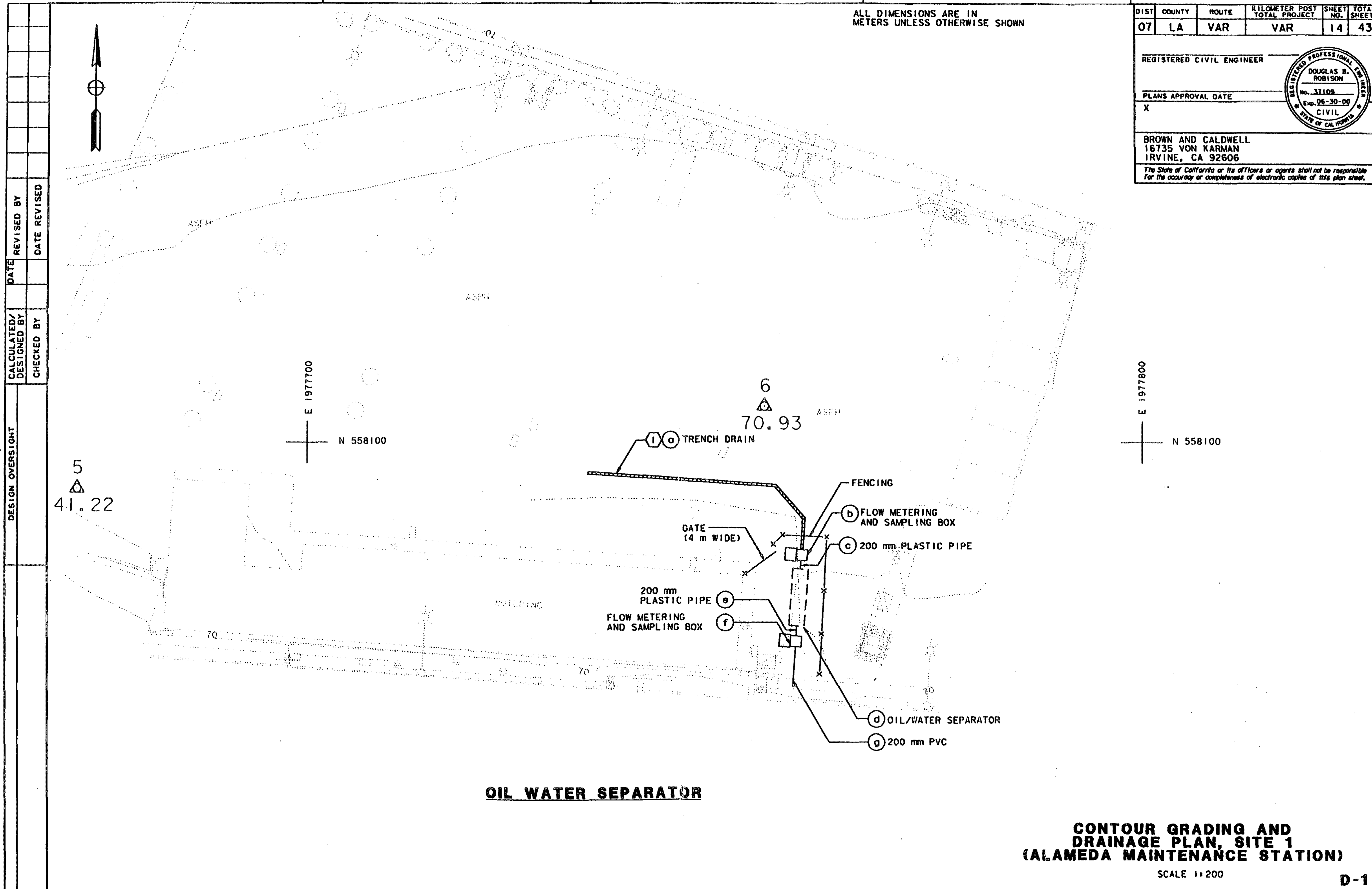
Plans Approval Date

BROWN AND CALDWELL
16735 VON KARMAN
IRVINE, CA 92606

Contract No.

The Contractor shall possess the Class (or Classes) of license as specified in the ''Notice to Contractors''.

DATE | PROJECT ENGINEER | DATE | PROJECT MANAGER | DATE



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PLANS APPROVAL DATE
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ASPH
BUILDING
70
1 a TRENCH DRAIN
FENCING
b FLOW METERING AND SAMPLING BOX
GATE (4 m WIDE)
c 200 mm PLASTIC PIPE
200 mm PLASTIC PIPE e
FLOW METERING AND SAMPLING BOX f
d OIL/WATER SEPARATOR
g 200 mm PVC
OIL WATER SEPARATOR
CONTOUR GRADING AND DRAINAGE PLAN, SITE 1 (ALAMEDA MAINTENANCE STATION)
SCALE 1:200
D-1

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
X	LA	VAR	VAR	15	43

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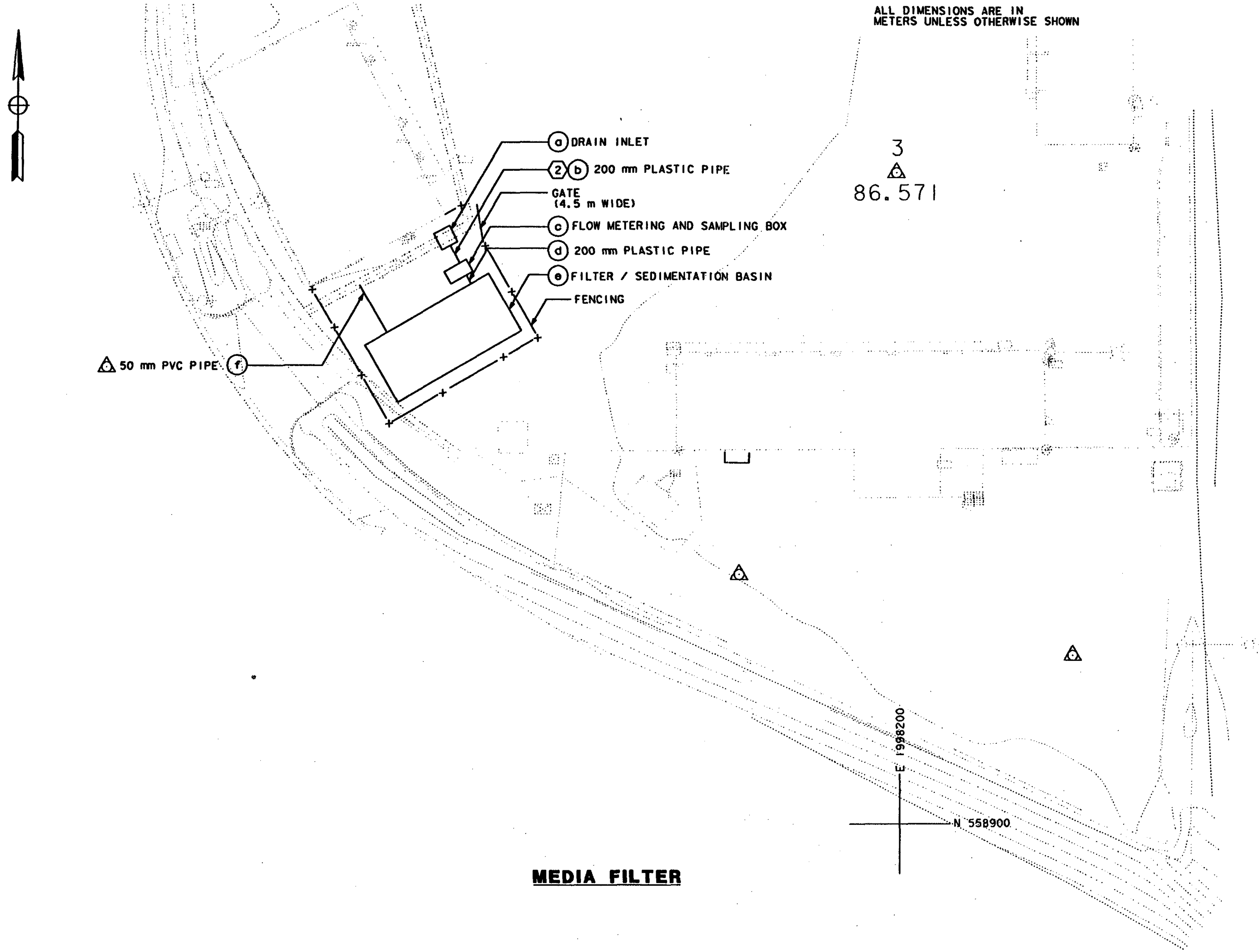

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CONTOUR GRADING AND DRAINAGE PLAN, SITE 2 (EASTERN REGIONAL MAINTENANCE STATION)

SCALE 1:200

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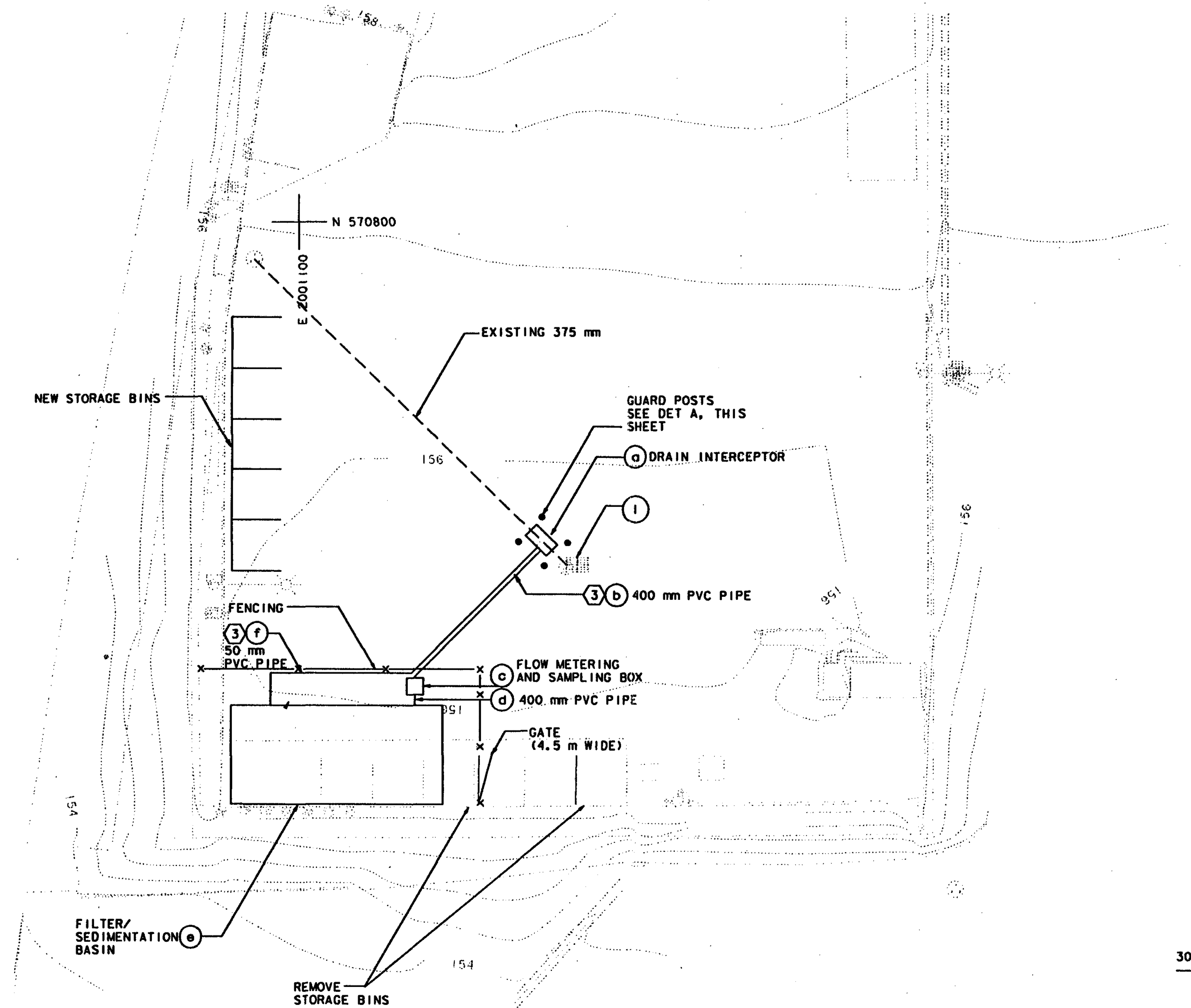

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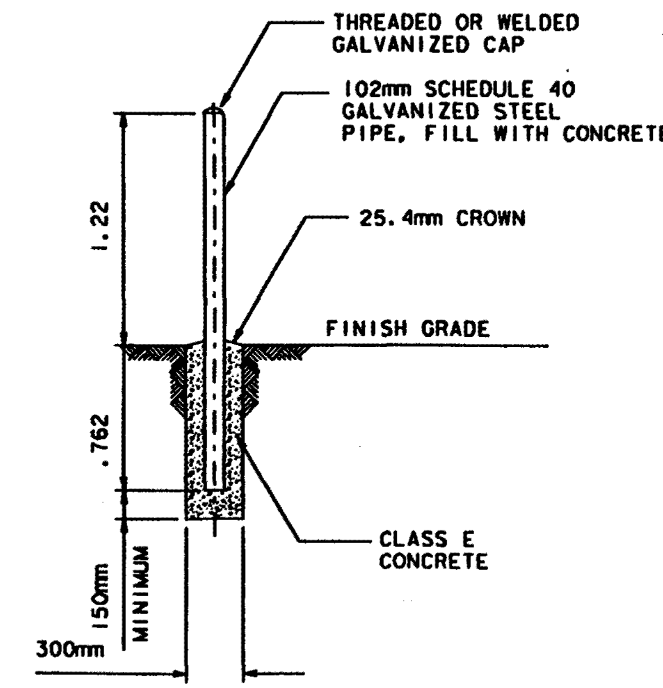
CONSTRUCTION NOTES

1 CONNECT TO EXISTING DRAIN INLET



DETAIL A/-
SCALE: 1:20

CONTOUR GRADING AND DRAINAGE PLAN, SITE 3 (FOOTHILL MAINTENANCE STATION)

SCALE 1:200

D-3

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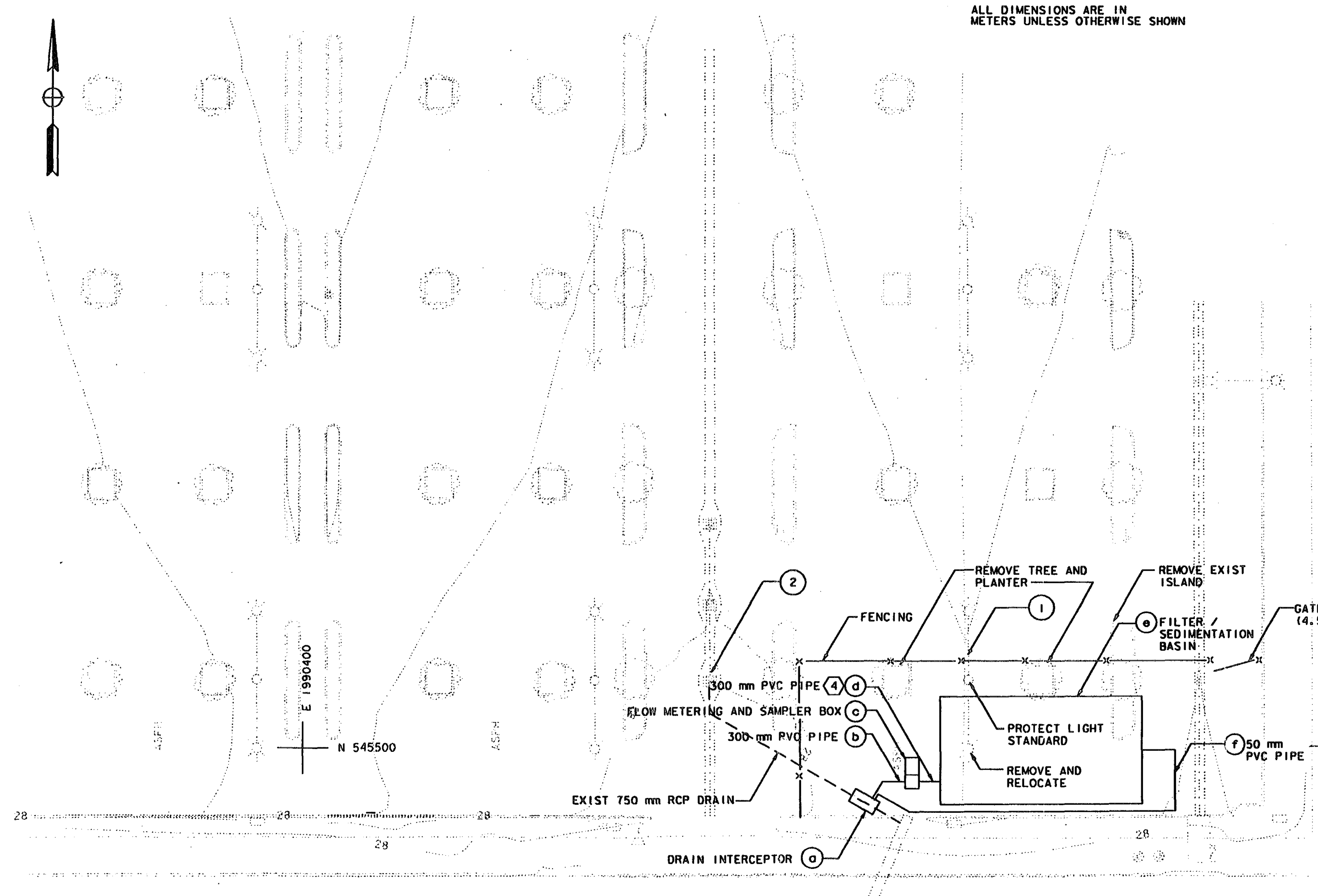

CONSTRUCTION NOTES

1. RELOCATE ANY EXISTING UNDERGROUND WIRING ON THE PROPOSED SITE
2. INSTALL DRAIN INTERCEPTOR, SEE DETAIL 1/D-16

MEDIA FILTER

CONTOUR GRADING AND DRAINAGE PLAN, SITE 4 (TERMINATION PARK AND RIDE)

SCALE 1:200

D-4

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
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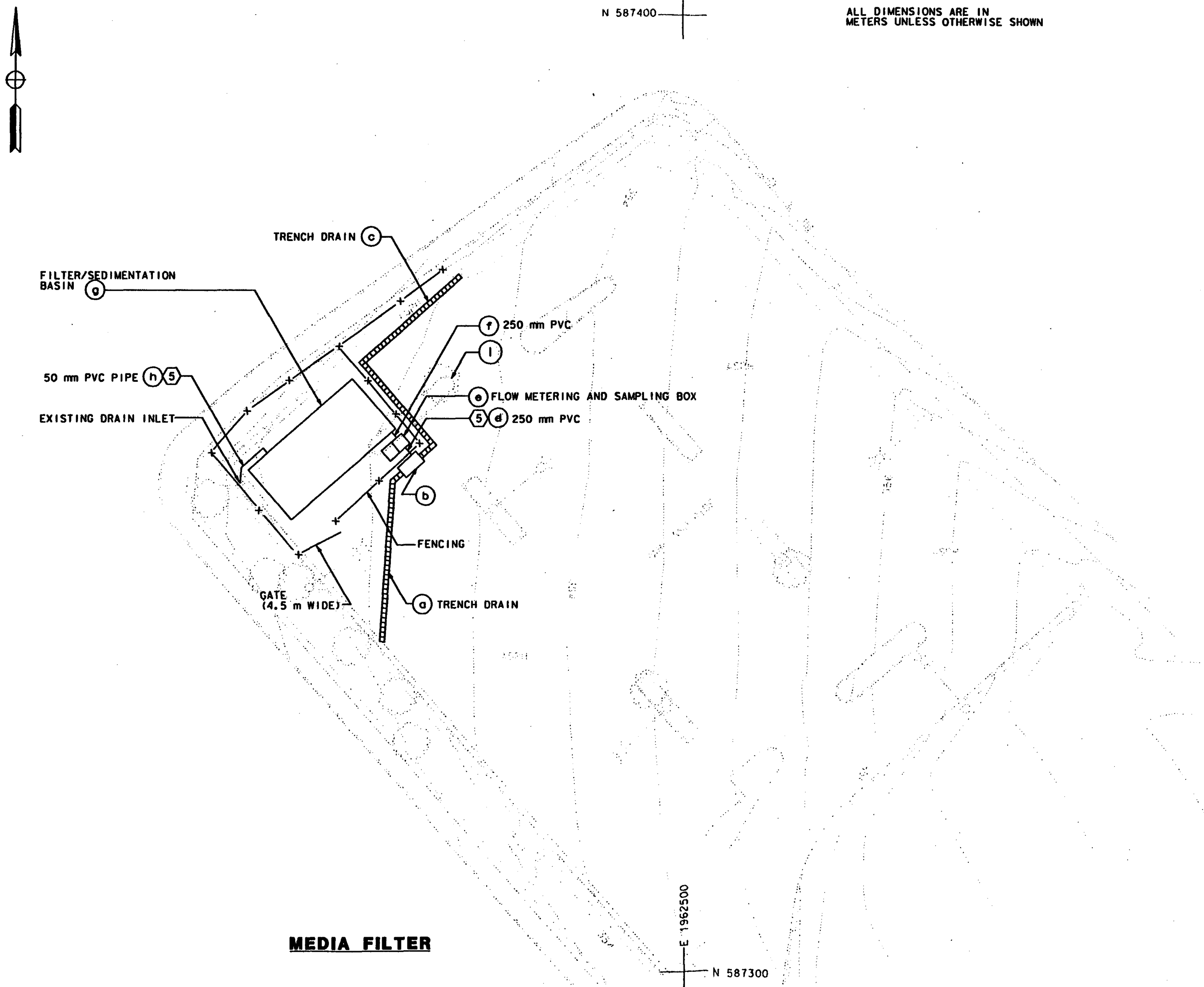

MEDIA FILTER

CONSTRUCTION NOTES

(1) REMOVE EXISTING ISLAND AND TREE

CONTOUR GRADING AND DRAINAGE PLAN, SITE 5 (PAXTON PARK AND RIDE)

SCALE 1:200

D-5

ALL DIMENSIONS ARE IN
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DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
07	LA	VAR	VAR	19	43

REGISTERED CIVIL ENGINEER

PLANS APPROVAL DATE

X

REGISTERED PROFESSIONAL ENGINEER
DOUGLAS B. ROBISON
No. 37109
Exp. 06-30-00
CIVIL
STATE OF CALIFORNIA

BROWN AND CALDWELL
16735 VON KARMAN
IRVINE, CA 92606

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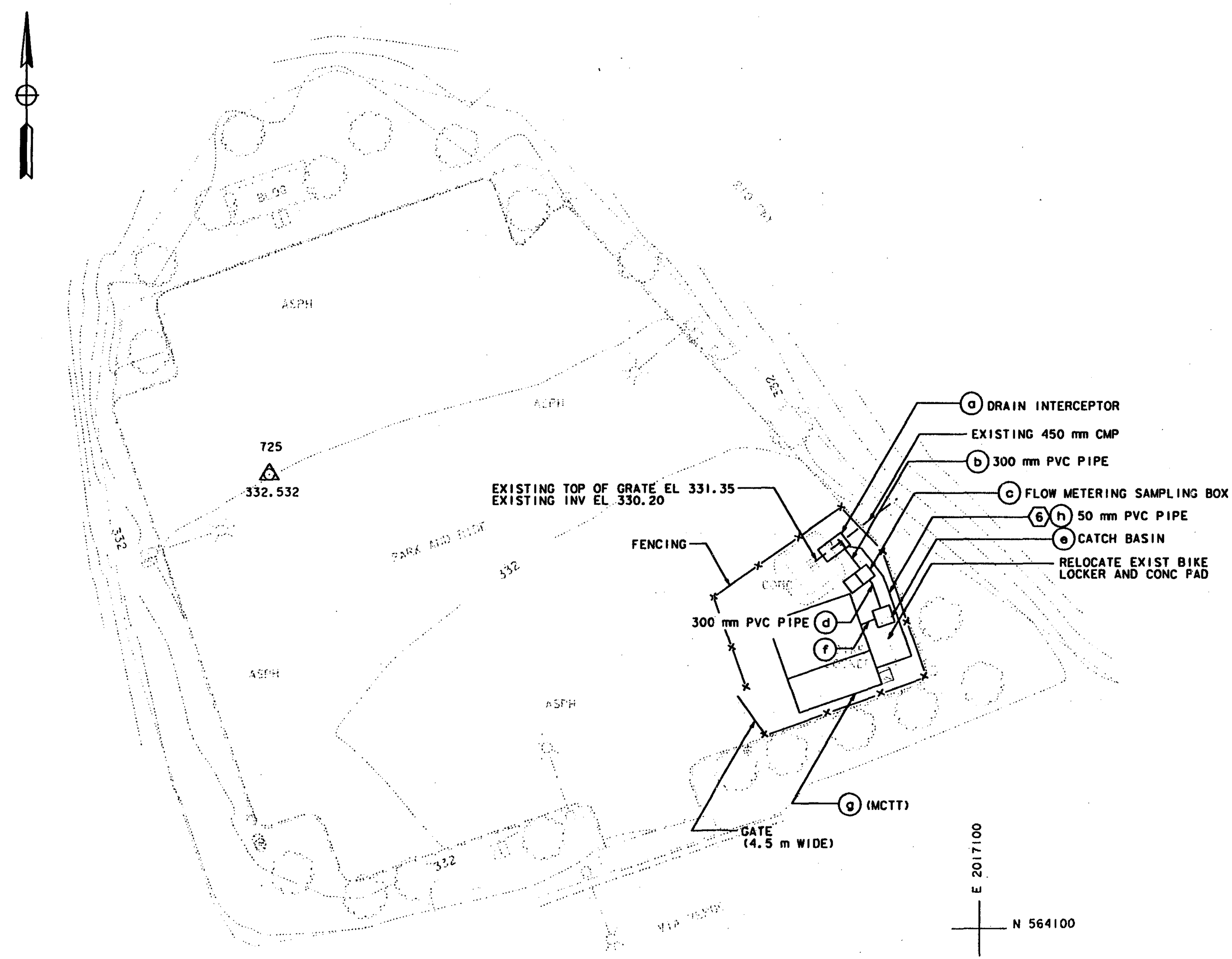
DATE | REVISED BY | DATE REVISED | CALCULATED/ DESIGNED BY | CHECKED BY | DESIGN OVERSIGHT



MULTI-CHAMBER TREATMENT TRAIN (MCTT)

CONTOUR GRADING AND DRAINAGE PLAN, SITE 6 (VIA VERDE PARK AND RIDE)

SCALE 1:200

D-6

ALL DIMENSIONS ARE IN
METERS UNLESS OTHERWISE SHOWN

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
07	LA	VAR	VAR	20	43

REGISTERED CIVIL ENGINEER

PLANS APPROVAL DATE

X

REGISTERED PROFESSIONAL ENGINEER
DOUGLAS B. ROBISON
No. 37109
Exp. 06-30-00
CIVIL
STATE OF CALIFORNIA

BROWN AND CALDWELL
16735 VON KARMAN
IRVINE, CA 92606

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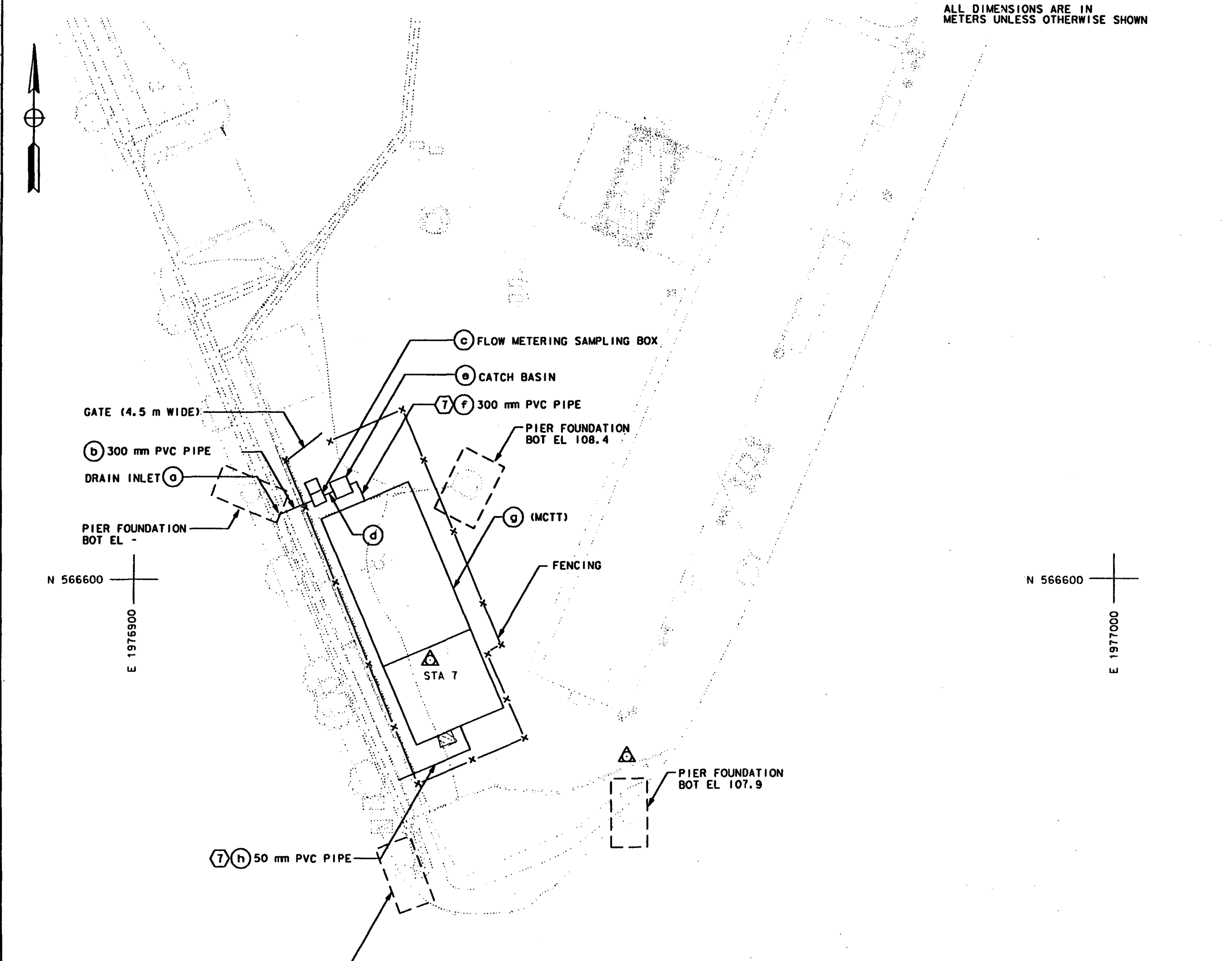

MULI-CHAMBER TREATMENT TRAIN (MCTT)

CONTOUR GRADING AND DRAINAGE PLAN, SITE 7 (METRO MAINTENANCE STATION)

SCALE: 1:200

D-7

DATE | REVISED BY | DATE REVISED

CALCULATED/DESIGNED BY | CHECKED BY

DESIGN OVERSIGHT

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
07	LA	VAR	VAR	36	43

REGISTERED CIVIL ENGINEER

PLANS APPROVAL DATE

X

REGISTERED PROFESSIONAL ENGINEER
DOUGLAS B. ROBISON
No. ROBISON
Exp. 06-30-00
CIVIL
STATE OF CALIFORNIA

BROWN AND CALDWELL
16735 VON KARMAN
IRVINE, CA 92606

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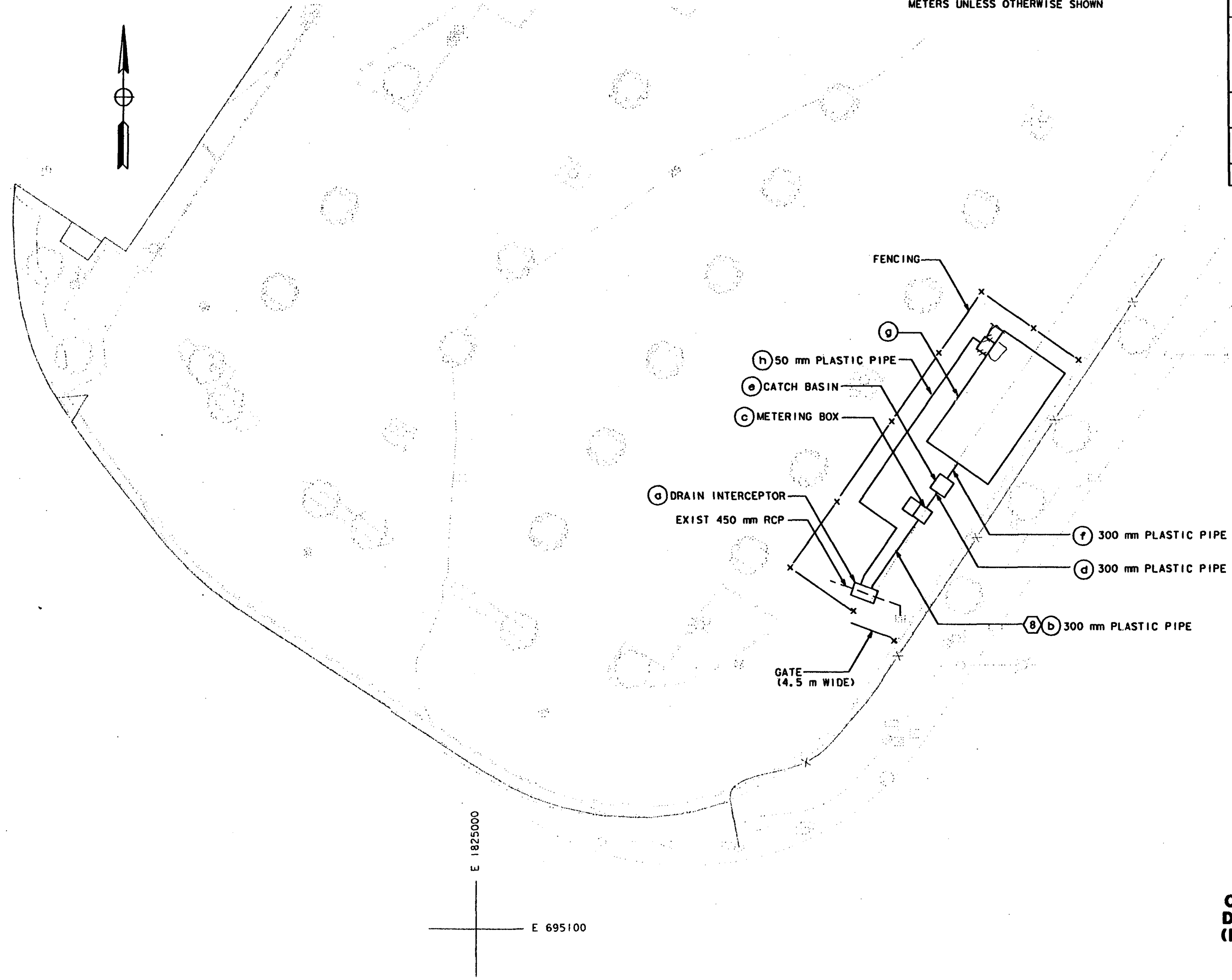


CONTOUR GRADING AND DRAINAGE PLAN, SITE 8 (I-105/LAKEWOOD BLVD)

SCALE 1:200

D-23

DATE	REVISED BY	DATE REVISED
CALCULATED/DESIGNED BY		CHECKED BY
DESIGN OVERSIGHT		

APPENDIX B

TREATMENT UNIT SITES PHOTOGRAPHS

Fig. 1 Alameda Maintenance Station.

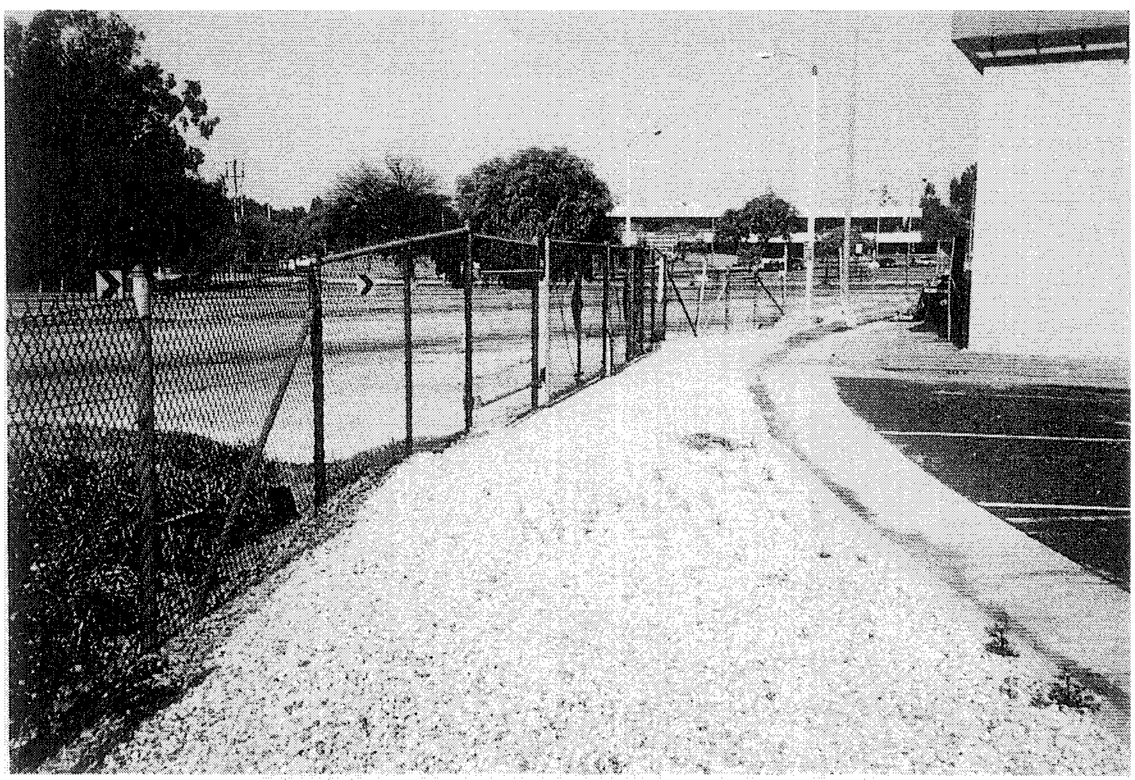


Fig. 2 Eastern Regional Maintenance Station

Fig. 3 Foothill Maintenance Station.

Fig. 4 Termination Park and Ride

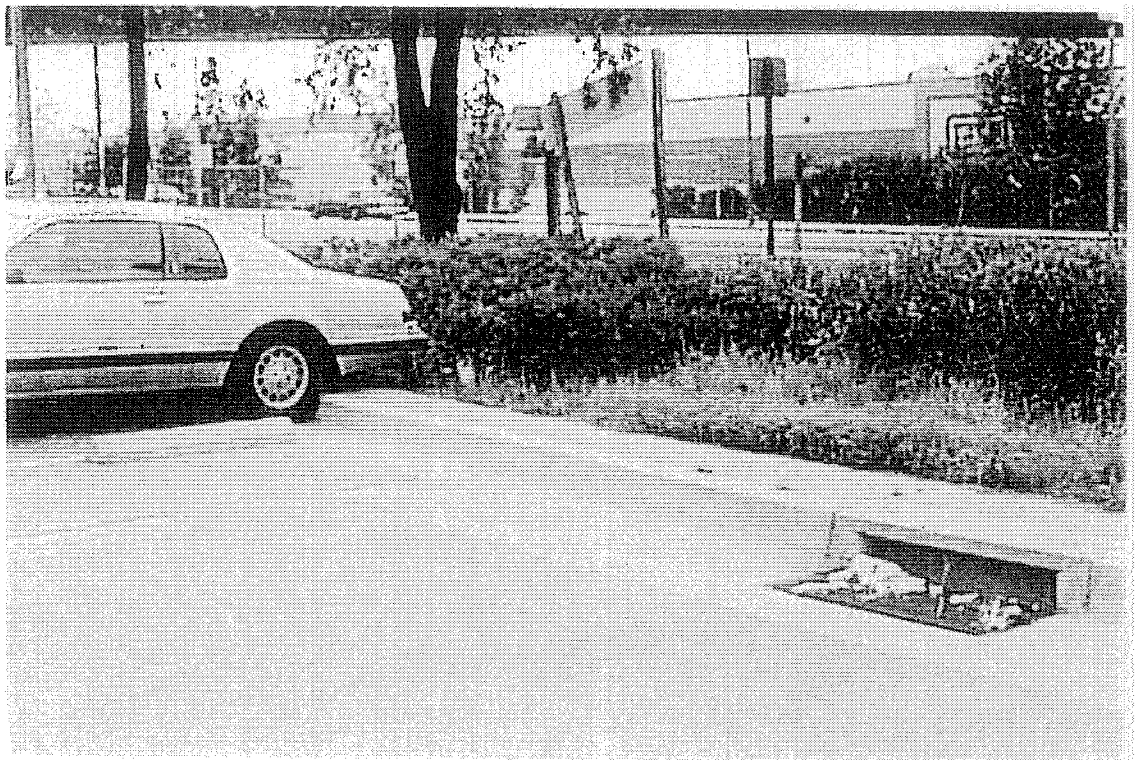


Fig. 5 Paxton Park and Ride

Fig. 6 Via Verde Park and Ride

Fig. 7 Metro Maintenance Station

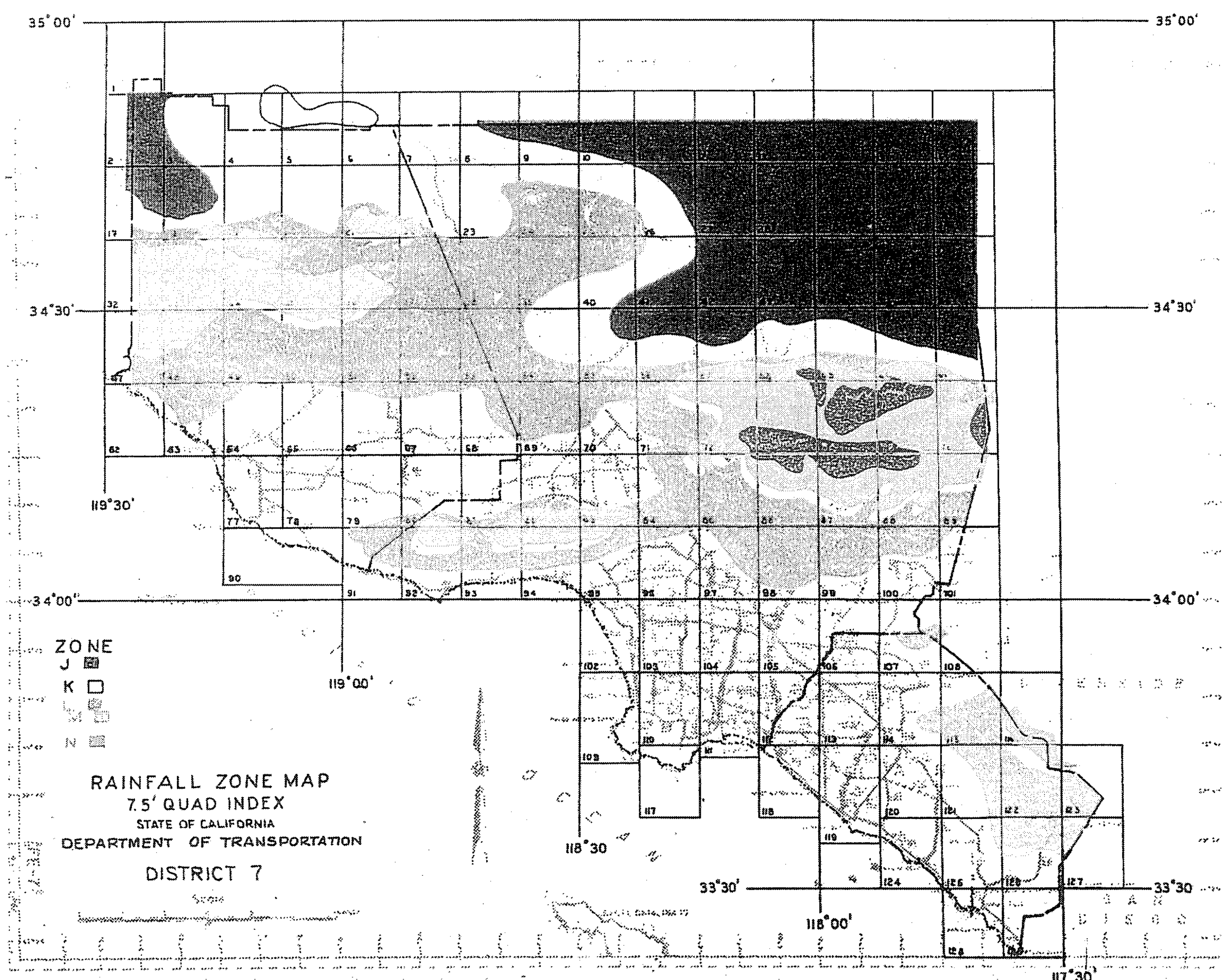
Fig. 8 Lakewood Park and Ride

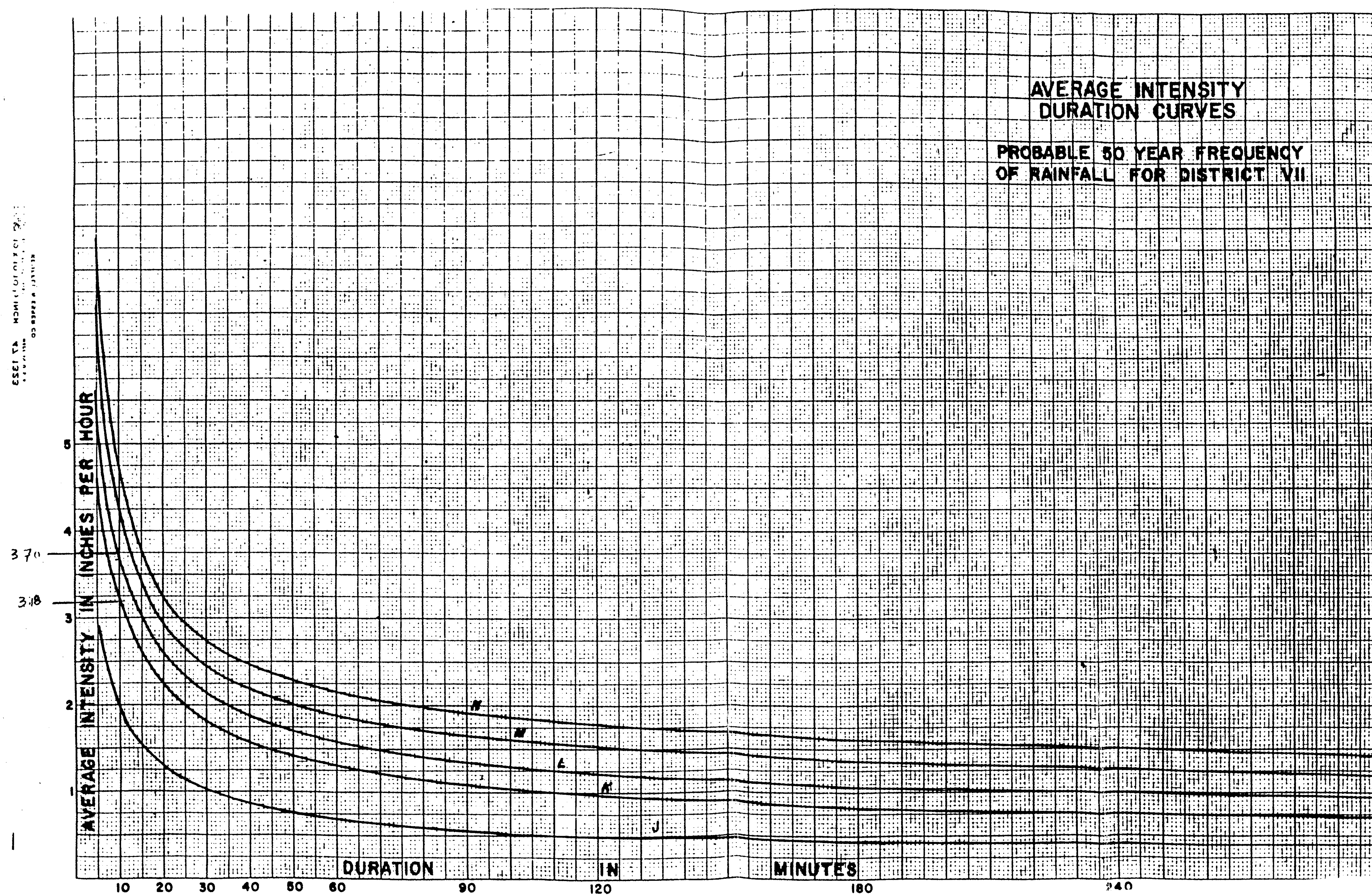
APPENDIX C

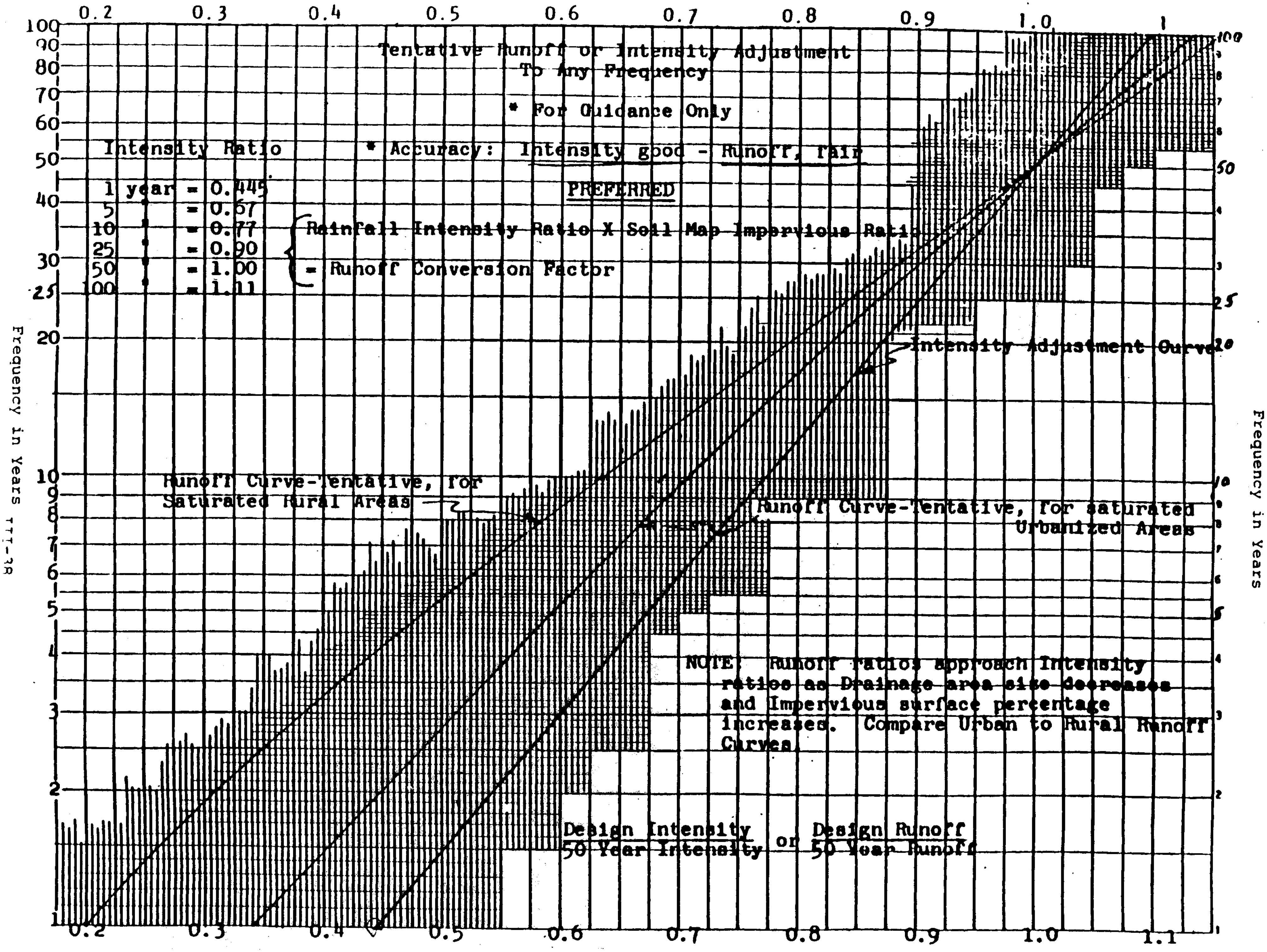
RAINFALL ZONE MAP

TREATMENT UNIT CALCULATIONS

1 Ballinger Canyon
2 Cuyama Peak
3 Apache Canyon
4 Sawmill Mountain
5 Cuddy Valley
6 Frazier Mountain
7 Lebec
8 La Libre Ranch
9 Neenach School
10 Fairmont Butte
11 Little Buttes
12 Rosamond
13 Rosamond Lake
14 Redman School
15 Mount Mesa
16 Kramer
17 Rancho Nuevo Creek
18 Reyes Peak
19 San Guillermo
20 Lockwood Valley
21 McDonald Peak
22 Black Mountain
23 Liebre Mountain
24 Burnt Peak
25 Lake Hughes
26 Del Sur
27 Lancaster West
28 Lancaster East
29 Alpine Butte
30 Hi Vista
31 Adobe Montain
32 Old Man Mountain
33 Wheeler Springs
34 Lion Canyon
35 Topatopa Mountain
36 Devils Heart Peak
37 Cobblestone Mountair
38 Whitaker Peak
39 Warm Springs Mountain
40 Green Valley
41 Sleepy Valley
42 Ritter Ridge
43 Palmdale
44 Littlerock
45 Lovejoy Buttes
46 El Mirage
47 White Ledge Peak
48 Matilija
49 Ojai
50 Santa Paula Peak
51 Fillmore
52 Piru
53 Val Verde
54 Newhall
55 Mint Canyan
56 Aqua Dulce
57 Acton
58 Pacifico Mountian
59 Juniper Hills
60 Valyermo
61 Mescal Creek
62 Pitas Point
63 Ventura
64 Saticoy
65 Santa Paula
66 Moorpark
67 Simi
68 Santa Susana
69 Oat Mountain
70 San Fernando
71 Sunland
72 Condor Peak
73 Chilao Flat
74 Waterman Mountain
75 Crysal Lake
76 Mt. San Antonio
77 Oxnard
78 Camarillo
79 Newbury Park
80 Thousand Oaks
81 Calabasas
82 Canoga Park
83 Van Nuys
84 Burbank
85 Pasadena
86 Mt. Wilson
87 Azusa
88 Glendora
89 Mt. Baldy
90 Point Mugu
91 Triunfo Pass
92 Point Dume
93 Malibu
94 Topanga
95 Beverly Hills
96 Hollywood
97 Los Angeles
98 El Monte
99 Baldwin Park
100 San Dimas
101 Ontario
102 Venice
103 Inglewood
104 South Gate
105 Whittier
106 La Habra
107 Yorba Linda
108 Prado Dam
109 Redondo Beach
110 Torrance
111 Long Beach
112 Los Alamitos
113 Anaheim
114 Orange
115 Black Star Canyon
116 Corona South
117 San Pedro
118 Seal Beach
119 Newport Beach
120 Tustin
121 El Toro
122 Santiago Peak
123 Alberhill
124 Laguna Beach
125 San Juan Capistrano
126 Canada Gobernadora
127 Sitton Peak
128 Dana Point
129 San Clemente




AVERAGE INTENSITY
DURATION CURVES
PROBABLE 50 YEAR FREQUENCY
OF RAINFALL FOR DISTRICT VII
AVERAGE INTENSITY IN INCHES PER HOUR
DURATION IN MINUTES
1
2
3
4
5
3.70
3.18
10
20
30
40
50
60
90
120
180
240
N
M
L
K
J


Tentative Runoff or Intensity Adjustment
To Any Frequency
* For Guidance Only
Intensity Ratio
* Accuracy: Intensity good - Runoff, fair
PREFERRED
1 year = 0.445
5 " = 0.67
10 " = 0.77
25 " = 0.90
50 " = 1.00
100 " = 1.11
Rainfall Intensity Ratio X Soil Map Impervious Ratio
= Runoff Conversion Factor
Intensity Adjustment Curve
Runoff Curve-Tentative, for Saturated Rural Areas
Runoff Curve-Tentative, for saturated Urbanized Areas
NOTE: Runoff ratios approach Intensity ratios as Drainage area size decreases and Impervious surface percentage increases. Compare Urban to Rural Runoff Curves.
Design Intensity / 50 Year Intensity or Design Runoff / 50 Year Runoff
Frequency in Years
Frequency in Years

BROWN AND
CALDWELL

REFERENCES NOTES

Peak Storm Water Runoff Flow Rate:

Using 50 yr. Duration curve and converting it to 1 yr., 24 hr. storm using intensity ratio

= 0.445 = $\frac{\text{1 yr. peak intensity}}{\text{50 yr. peak intensity}}$

Intensity Duration curves from Caltrans Dist. 7 Hyd. Manual

Duration = time of Concentration

t_c = > 10 minutes for all sites except Via Verde & Foothill M. Yard

For curve 50 yr. frequency

All sites except Via Verde & Foothill

50-yr. intensity, inches/hr = 3.18

Converting to 1 yr. design storm using intensity ratio of 0.445

	1 yr. peak intensity in/hr
All sites except Via Verde & Foothill	0.445 × 3.18 = 1.41

Peak Rainfall Rate

Alameda = 0.75 acres × 43,560 × ft²/acre × 1.41 in/hr × 1 ft/12 in × 7.48 gal/ft³ × hr/60 min × 1 = 474 gal/min.

DATE CHECKED	CHECKED BY	JOB NUMBER	BY	DATE	CALC. NO.	SHEET NO.

PROJECT	SUBJECT

GEN-020-10/96

CALDWELL

REFERENCES NOTES

2. Eastern Regional

$$= 1.45 \times 43560 \times 1.41 \times \frac{1}{12} \times 7.48 \times \frac{1}{60} \times 0.9$$

$$= 826 \text{ gpm.}$$

3 Metro Maint. Sta.

$$= 4.58 \times 43560 \times 1.41 \times \frac{1}{12} \times 7.48 \times \frac{1}{60} \times 1.0$$

$$= 2901 \text{ gpm}$$

4. Termination Park & Ride

$$= 2.79 \times 43560 \times 1.41 \times \frac{1}{12} \times 7.48 \times \frac{1}{60} \times 0.9$$

$$= 1,539 \text{ gpm}$$

5. Paxton P& R

$$= 1.34 \times 43560 \times 1.41 \times \frac{1}{12} \times 7.48 \times \frac{1}{60} \times 0.9$$

$$= 765 \text{ gpm}$$

6. Lakewood

$$= 1.93 \times 43560 \times 1.41 \times \frac{1}{12} \times 7.48 \times \frac{1}{60} \times 1.0$$

$$= 1221 \text{ gpm}$$

DATE CHECKED	CHECKED BY	JOB NUMBER	BY	DATE	CALC. NO.	SHEET NO.

PROJECT	SUBJECT

REFERENCES NOTES

For Via Verde & Foothill
From curve 50 yr. frequency curve L.

$$= 3.71$$

Converting to 1 yr. design storm using intensity ratio of 0.445

$$= 0.445 \times 3.71 = 1.67$$ 1 yr peak intensity in./hr

Peak Rainfall Rate

Via Verde

$$= 1.09 \text{ acre} \times 43560 \frac{ft^2}{acre} \times 1.67 \frac{inch}{hr} \times \frac{1}{12} \frac{ft}{in} \times 7.48 \frac{gal}{ft^3}$$

$$\times \frac{hr}{60 \text{ min}} \times 0.9 = 732 \text{ gpm}$$

Foothill

$$= 1.75 \times 43560 \times 1.67 \times \frac{1}{12} \times 7.48 \times \frac{1}{60} \times 1.0 = 1312$$ gpm

DATE CHECKED	CHECKED BY	JOB NUMBER	BY	DATE	CALC. NO.	SHEET NO.

PROJECT	SUBJECT

SIZING OF MEDIA FILTERS

SITE 2

E. REGIONAL Maintenance Station:

Volume of water = 115.63 cu.m.

= 4080 cu ft.

Assuming a depth of 7 ft for sedimentation basin.

Surface Area = $\frac{4080}{7}$ = 581.69 = 582 sq. ft.

Size of Sedimentation Basin = 582 sq. ft.

= 6.0 m x 9.0 m

= 54 m^2

= 582.0 sq. ft.

Media Filter Size

$$A_f = \frac{A_D H}{18}$$

A_D = Drainage Area = 1.45 acr. x 43560 = 63,162 sq ft

H = depth of rainfall = 1" = 1/12 ft

$$A_f = \frac{63162 \times 1/12}{18} = 292. \text{ sq ft}$$

A_f = 6.0 m x 4.5 m = 27 ~~291~~ m^2 = 291 ft^2

6150 JOB NUMBER	JT BY	SIZING OF TREATMENT UNITS SUBJECT	DATE	SHEET NO

BROWN AND CALDWELL CONSULTING ENGINEERS

SITE-2

FOOTHILL MAINTENANCE STP.

Volume of water = 216.90 m^3

= 7653.37 cft

Assuming a depth of 7 ft =

Surface Area of Sed. Basin = $\frac{7653.37}{7}$ = 1094 sqft

Size of Sed. Basin = 12.75 x 8.0 = 102 m^2

= 1097 sq ft

Media Filter

$$A_f = \frac{A_D H}{18}$$

A_D = Drainage Area = 1.75 acres x 43560 = 76,230 sq. ft

H = 1" = 1/12 ft

$$A_f = \frac{76,230 \times 1/12}{18}$$

Surface Area = A_f = 353 sq. ft

Size of Media Filter = 5m x 8.0m = 40 m^2

= 430 sq ft

JOB NUMBER	BY	SUBJECT	DATE	SHEET NO

GEN-005-3/5/8

Site 4 TERMINATION P & R

Vol of water = 222.36 m^3

= 7846.5 cft.

Assuming depth = 7'

Sedimentation Basin Surface Area = $\frac{7846.55}{7}$ = 1121 sq

Size of Sed. Basin = 12.0 m x 9.5 m

= 114 m^2

= 1226. ft^2

Media Filter -

$$A_f = \frac{A_d H}{18}$$

A_d = 2.79 acres = x 43560 = 121532.4 ft^2

H = 1" = 1/12 ft

$$A_f = \frac{121532.4 \times 1/12}{18}$$

A_f = 563 ft^2

Size of Media Filter = 6.0 m x 9.5 m = 57 m^2

= 613. ft^2

JOB NUMBER	BY	SUBJECT	DATE	SHEET NO.

BROWN AND CALDWELL CONSULTING ENGINEERS

Site 5

PAXTON PARK & RIDE

Sed. Basin.

Vol. of water: 107.11 m3

= 3779.65 ft³

Assuming Depth of Sed Basin: 7'

Surface Area of Sed. Basin = $\frac{3779.65}{7}$ = 540 sq ft

Size of Sed. Basin: 9.0 m x 6.0 m = 54 m²

= 581 sq ft = ok.

Media Filter

$A_f = \frac{A_s H}{18}$

A_s = 1.34 acres = 58370.4 sq. ft

H = 1/12 ft

$A_f = \frac{58370.4 \times 1/12}{18}$

= 271 sq. ft

Size of Media Filter: 4.5 m x 6.0 m = 27 m²

= 291.[illegible] ft.

JOB NUMBER	BY	SUBJECT	DATE	SHEET NO.

GEN-005-3/5/85

Alameda Maintenance Sta:

Volume of water = 65.15 m³

= 2299.33 cft

= 17,196.3 ≈ 17,200 gal

Unit selected for site:

Runoff Volume for Caltrans Pilot Study Sites Based on Retrofit Method

BMP Location	Drainage area, acres	Imperviousness [a]	Rainfall Zone	Rainfall, inches	Peak Rainfall, inches/hr	Peak Flow, gpm (Q=CIA)	Volume of Water, gal [b]	Volume of Water, cubic meters	Sed. Basin Area	Media Filter Area
Alameda Maintenance Station	0.75	100%	K	1	1.41	474	17,212	65.15	329	
Eastern Regional Maintenance Station	1.45	90%	K	1	1.41	826	30,549	115.63	583	293
Metro Maintenance Station	4.58	100%	K	1	1.41	2,901	105,288	398.52		
Foothill Maintenance Station	1.75	100%	L	1.4	1.67	1,312	57,305	216.90	1,094	353
Termination Park and Ride	2.79	90%	K	1	1.41	1,589	58,748	222.36	1,122	563
Via Verde Park and Ride	1.09	90%	L	1.4	1.67	732	32,590			
Paxton Park and Ride	1.34	90%	K	1	1.41	765	28,300	107.11	540	271
S605.91 (S)	0.80	100%	K	1	1.41	506	18,377	69.56		
S5/S605	6.80	54%	K	1	1.41	2,324	96,325	364.59		
I-5/Lakewood Blvd Park and Ride	1.93	100%	K	1	1.41	1,221	44,334	167.80		

a - Based on field study for Retrofit Project
b -The volume of rain is calculated based upon 0.06-inches of rain loss due to local ponding and 90-percent runoff from impervious surfaces and 15-pecent runoff from pervious surfaces

APPENDIX D

CONSTRUCTION COST

Construction Costs from July Bid

Site	Construction Cost
#1 Alameda	$172,040
#2 Eastern	$267,570
#3 Foothill	$400,648
#4 Termination	$372,982
#5 Paxton	$317,947
#6 Via Verde	$309,633
#7 Metro	$483,911
#8 Lakewood	$388,038
TOTAL	**$2,712,769**

APPENDIX E

PRELIMINARY SOILS REPORT

THE L·K·R GROUP
CONSULTING GEOTECHNICAL ENGINEERS

PROJECT MEMORANDUM

Brown and Caldwell
16735 Von Karrman
Irvine, CA 92606

June 12, 1998

97-1019E

Attention: **Mr. Robert Finn**

Subject: Geotechnical Design Parameters for Caltrans District 7 I-105/Lakewood Blvd, Via Verde, Metro, Paxton, Foothill, Termination, Eastern Regional and Alameda sites

Robert:

We are submitting preliminary design data as requested for shoring and retaining walls for the referenced sites. Boring logs will be included with the design data.

Shoring

Design of shoring for the proposed excavations, should utilize the following design parameters:

TABLE 1: SHORING DESIGN DATA

Structural Pressures	Cohesion (lb/ft^2)	Cohesion (kPa)	Friction Angle (deg)	Unit Wt. (lb/ft^3)	Unit Wt. (kN/m^3)
I-105/Lakewood	0	0	30	125	19.6
Via Verde P & R	0	0	33	120	18.8
Metro M. S.	0	0	30	120	18.8
Paxton P & R	0	0	33	120	18.8
Foothill M. S.	0	0	30	120	18.8
Termination P & R	0	0	34	125	19.6
East Regional M. S.	0	0	34	125	19.6
Alameda M. S.	0	0	30	120	18.8

All shoring shall be designed by the contractor in accordance with the California Trenching and Shoring Manual and shall conform to the California Code of Regulations Title 8, Construction Safety Orders Sections 1504, 1539 – 1543.

Active and At-Rest Pressure

Walls of the BMP and other buried pipes and structures will be subjected to lateral earth pressures from the retained soils. Caltrans Structural Backfill shall be used per Standard Specifications 19-3.06. Assuming structural backfill is used, walls should be designed to resist an equivalent fluid pressure of 36 lb/ft^3 (5.6 kN/m^3)

The lateral earth pressures should be applied in a triangular pressure distribution. The resultant force for the at-rest condition should be applied at the mid-height of the wall. The value is based on the assumptions that; (1) back-fill is level with a height no greater than 30-feet, and; (2) back-fill materials are well-drained and non-expansive with an Expansion Index (EI) no greater than 30, as determined by the UBC Standard Test 29-2.

Determination of appropriate wall design conditions (active or at-rest) will depend on the flexibility of the wall. Cantilevered walls are those capable of rotating at least 0.001 radian about their base. Walls restrained against rotation should be designed for appropriate at-rest earth pressures.

Surcharge loads (dead or live) should be added to the indicated lateral earth pressures. Surcharge pressures should be applied as a uniform (rectangular) pressure distribution. A traffic surcharge of 2-feet (600 mm) of soil shall be added where appropriate. The corresponding lateral earth pressure coefficients for a uniform vertical surcharge behind the wall and bearing values are as follows:

TABLE 2: UNIFORM VERTICAL SURCHARGE AND BEARING VALUE

Site	Wall Design Condition	Lateral Earth Pressure Coefficients	Bearing Value (lb/ft^2)	(kPa)	Settlement (in)	(mm)
I-105/Lakewood	Active	0.33	2000	95.6	2/3	17
	At-Rest	0.50				
Via Verde P & R	Active	0.39	3000	143.6	1/2	13
	At-Rest	0.56				
Metro M. S.	Active	0.32	3000	143.6	1/2	13
	At-Rest	0.48				
Paxton P & R	Active	0.30	3000	143.6	1/2	13
	At-Rest	0.43				
Foothill M. S.	Active	0.33	2000	95.6	2/3	17
	At-Rest	0.50				
Termination	Active	0.30	4000	191	1/2	13
	At-Rest	0.45				
East Regional	Active	0.30	4000	191	1/2	13
	At-Rest	0.45				
Alameda M. S.	Active	0.33	2000	95.6	2/3	17

Vertical surcharges setback behind the wall at a horizontal distance greater than the exposed wall height, need not be added to the design pressures. Surcharge pressures due to concentrated loads may be evaluated after geometric constraints and loading conditions are determined.

Passive Pressure

Lateral load resistance may be provided by a combination of friction acting at the base of the slabs, and passive earth pressure developed against the sides of buried walls. Friction and passive pressure may be used in combination, without reduction, in determining the total resistance to lateral loads.

TABLE 3: LATERAL LOAD RESISTANCE

Site	Coefficient of Friction	Lateral Bearing Value ($lb/ft^2/ft$)	(kPa/m)
I-105/Lakewood	0.40	240	3.5
Via Verde P & R	0.45	200D+600	29D+8.75
Metro M. S.	0.40	200	2.9
Paxton P & R	0.45	300	4.3
Foothill M. S.	0.45	300	4.3
Termination P & R	0.45	300	4.3
East Regional M. S.	0.45	300	4.3
Alameda M. S.	0.40	240	3.5

D=Depth Below Lowest Adjacent Grade

A coefficient of friction may be used for dead loads acting upon on-site soils. The allowable lateral bearing value can be used for the sides of buried walls placed against competent native soils.

Corrosion Tests

Selected, combined samples from bulk samples were tested in the laboratory to evaluate soluble chlorides, soluble sulfates, pH and Minimum Resistivity in accordance with **ASTM D512-89, CTM 417, and CTM 643** test procedures, respectively. The results of the tests are given in ***Table 2, Corrosion Test.***

TABLE 4: CORROSION TEST

Boring No.	Sample Depth (m)	Soluble Sulfate (ppm)	Soluble Chloride (ppm)	Minimum Resistivity (ohm-cm)	pH
B-1	0.6-1.5	148	50	6,003	10.4
B-2	1.5-3.0	198	200	*	8.68
B-3	3.0-4.5	115	80	*	8.05
B-4	0.6-1.5	1,098	74	*	6.40
B-5	0.6-1.5	123	65	*	8.30
B-6	1.5-3.0	115	37	*	8.94
B-7	0.6-3.0	90	89	*	8.38
B-8	1.5-3.0	115	45	*	8.22

* in progress

Ground water was encountered at the I-105/Lakewood and the Metro during the field exploration and could be encountered during the excavation of the proposed BMPs. If such a situation occurs, the contractor should be prepared to de-water the site prior to construction in order to successfully complete the project. If de-watering of the proposed BMP is determined to be too costly, an alternate solution could be to re-design by raising the elevation of the BMP inverts.

Also, during excavating, there is still the possibility ground water may be encountered as other shallower perched ground water zones. This water should be de-watered during construction.

Cobbles may cause excavation difficulties at the Paxton and Foothill sites. At the Via Verde site, fill was encountered to below the BMP structure and sump pump inverts. At the present time information about the placement of the fill is unknown. While excavating in the fill, windrows or randomly placed cobbles and/or boulders could be encountered. Trash, rebar or used concrete can be another factor if uncovered within the fill during construction.

See boring logs for site specific lithology and encountered materials, ground water levels and moisture/density information.

A final report for each site will follow as completed.

If you have any questions, please do not hesitate to contact **The LKR Group, Inc**. at (310) 320-5100.

THE L.K.R GROUP, INC.

Steven Kolthoff, Project Geologist

971019e9

Attached Draft Log of Test Borings:

1) I-105/Lakewood Blvd. P & R
2) Termination P & R
3) Eastern Regional M. S.
4) Via Verde P & R
5) Foothill M. S.
6) Paxton P & R
7) Metro M. S.
8) Alameda M. S.

DIST	COUNTY	ROUTE	POST KILOMETERS TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
07	LA	VAR			

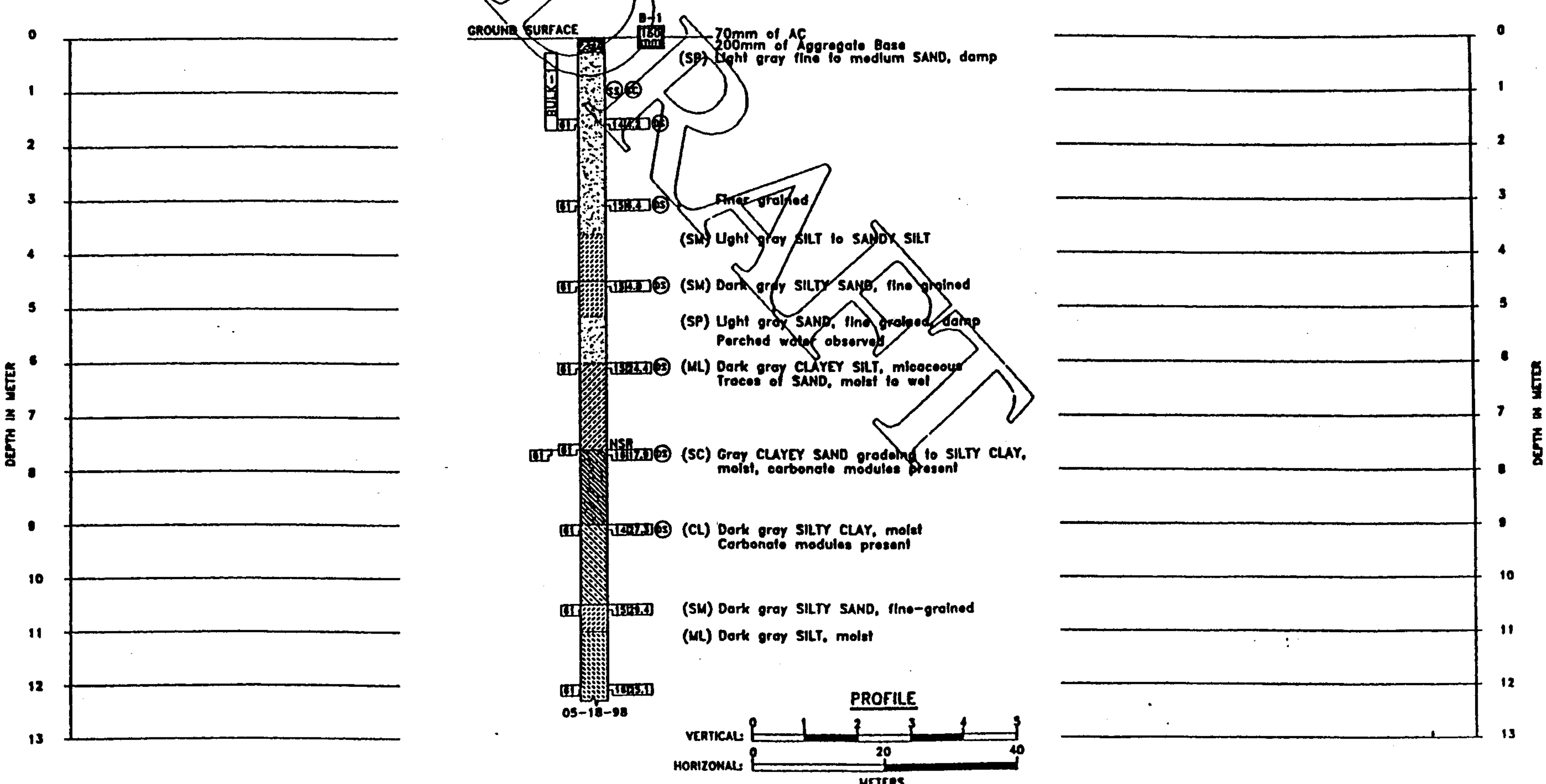
Steven Kolthoff
PROFESSIONAL GEOLOGIST

PLANS APPROVAL DATE

THE LKR GROUP
2341 205th. Street, Suite 103
Torrance, California 90501 Project No.:97-1009C

Laboratory Testing

- (DS) Direct Shear
- (SS) Soluble Sulfate
- (SC) Soluble Chloride
- (R) R- Value
- (C) Consolidation Test
- N.S.R. = No sample recovery
- OVM/OVA Gas Readings



DRAFT

LEGEND OF EARTH MATERIALS

CONSISTENCY CLASSIFICATION FOR SOILS

DRAWN BY L. NGUYEN

CHECKED BY STEVE KOLTHOFF

THE LKR GROUP

PREPARED FOR BROWN & CALDWELL

I-105/LAKEWOOD BOULEVARD P&R

Laboratory Testing

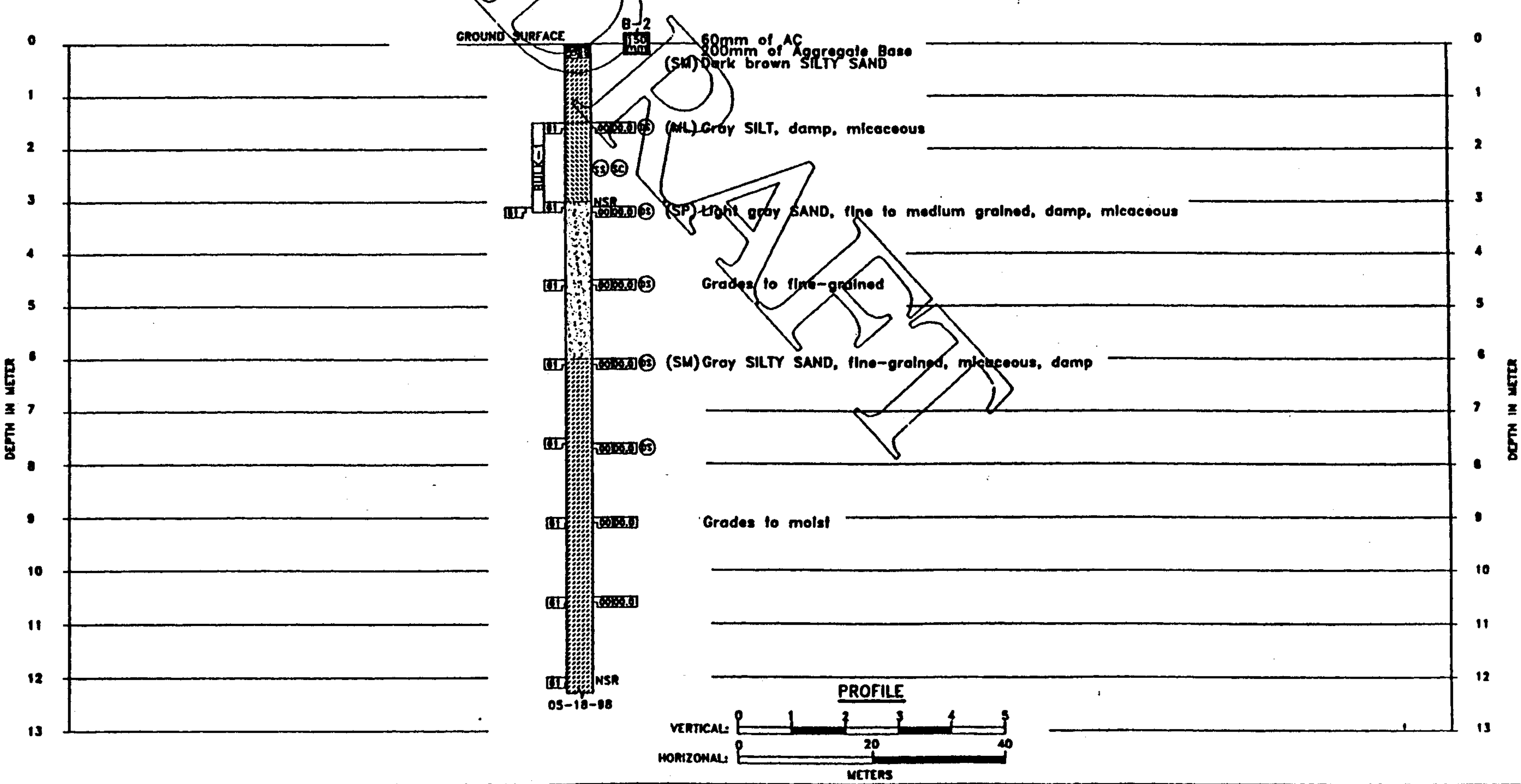
- (DS) Direct Shear
- (SS) Soluble Sulfate
- (SC) Soluble Chloride
- (R) R- Value
- (C) Consolidation Test
- N. S. R. = No sample recovery
- OVM2000 Gas Readings

DIST	COUNTY	ROUTE	POST KILOMETERS TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
07	LA	VAR			

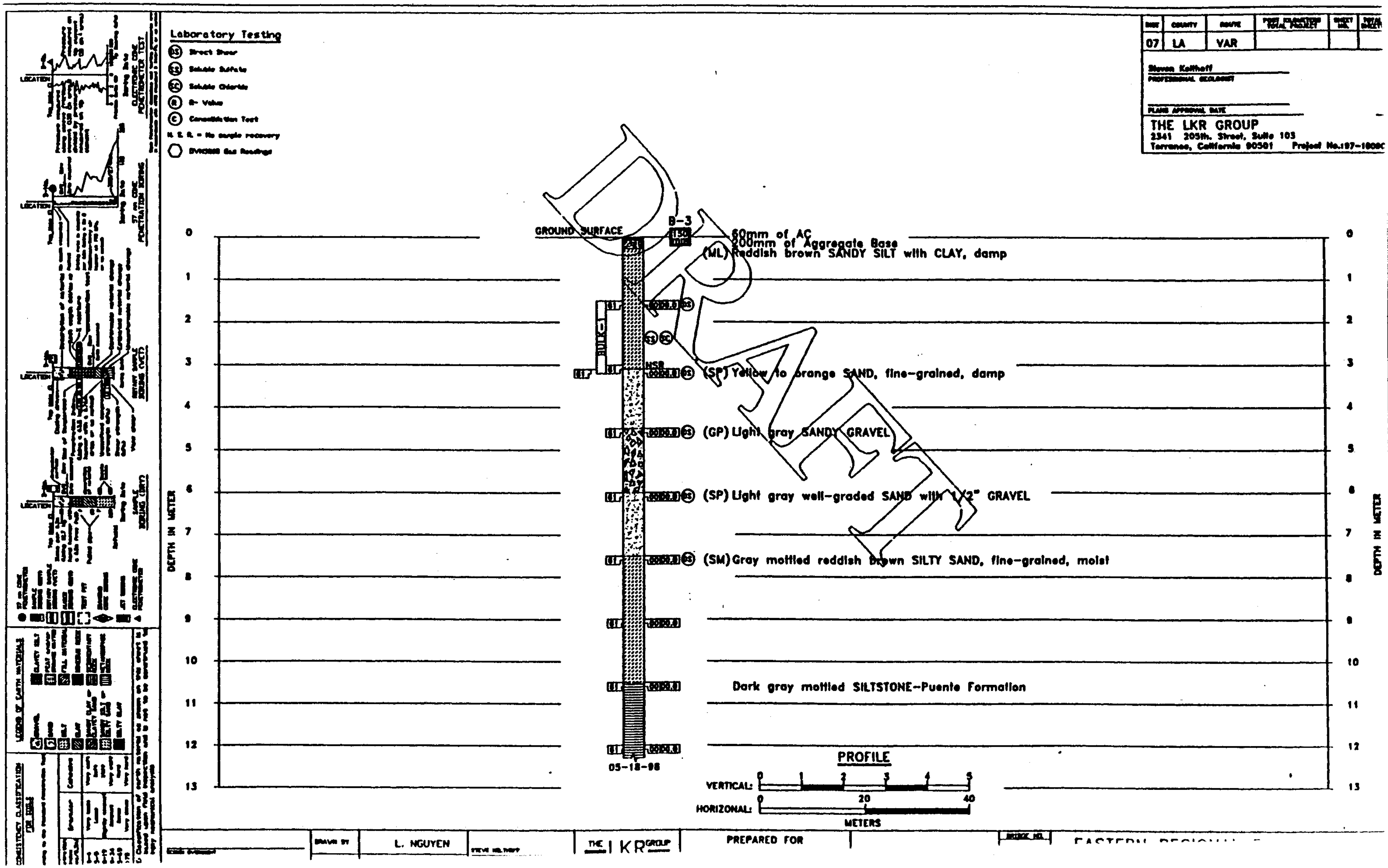
Steven Kolthoff
PROFESSIONAL GEOLOGIST

PLANS APPROVAL DATE

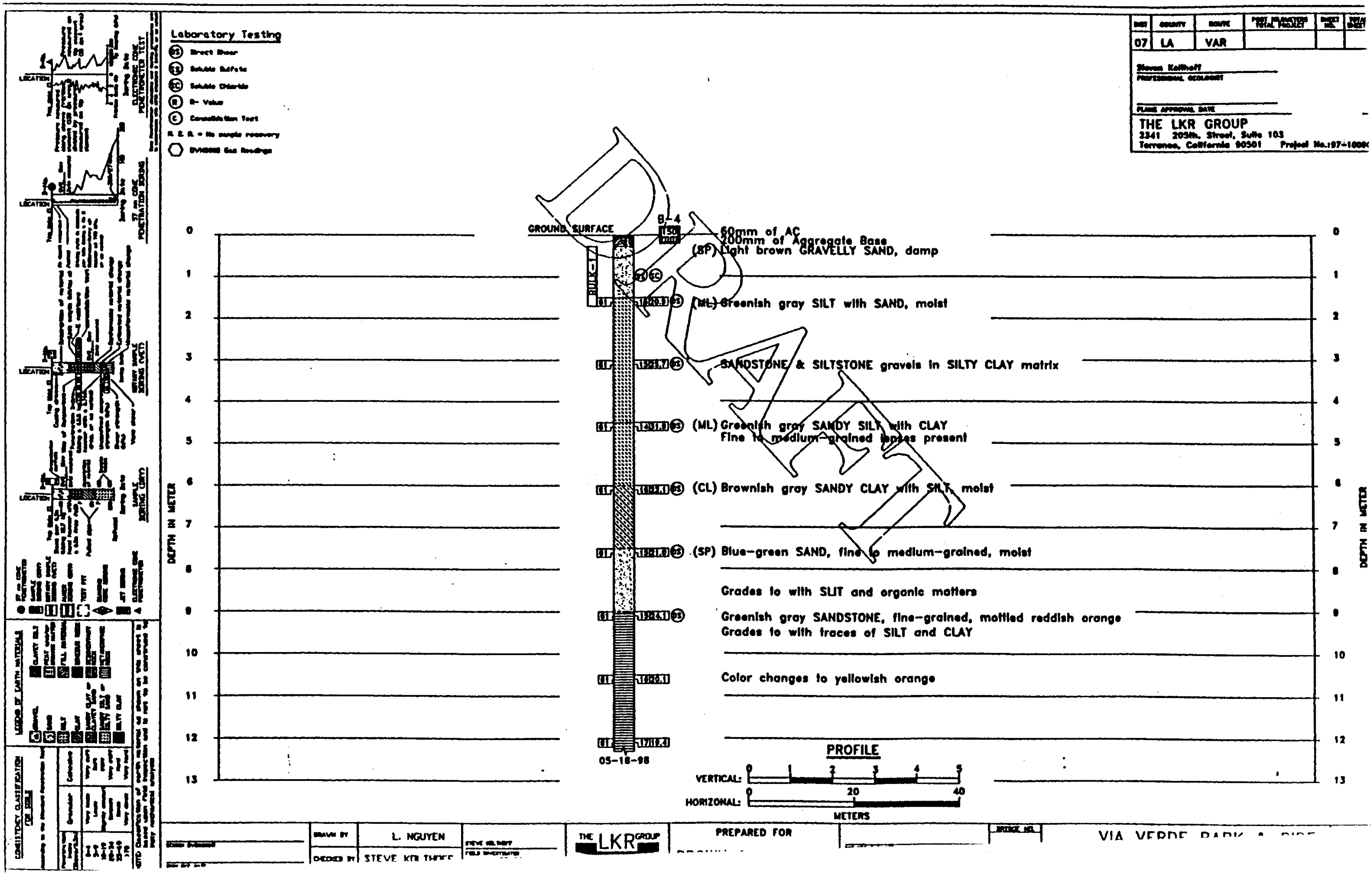
THE LKR GROUP
2341 205th. Street, Suite 103
Torrance, California 90501 Project No.:97-1008C



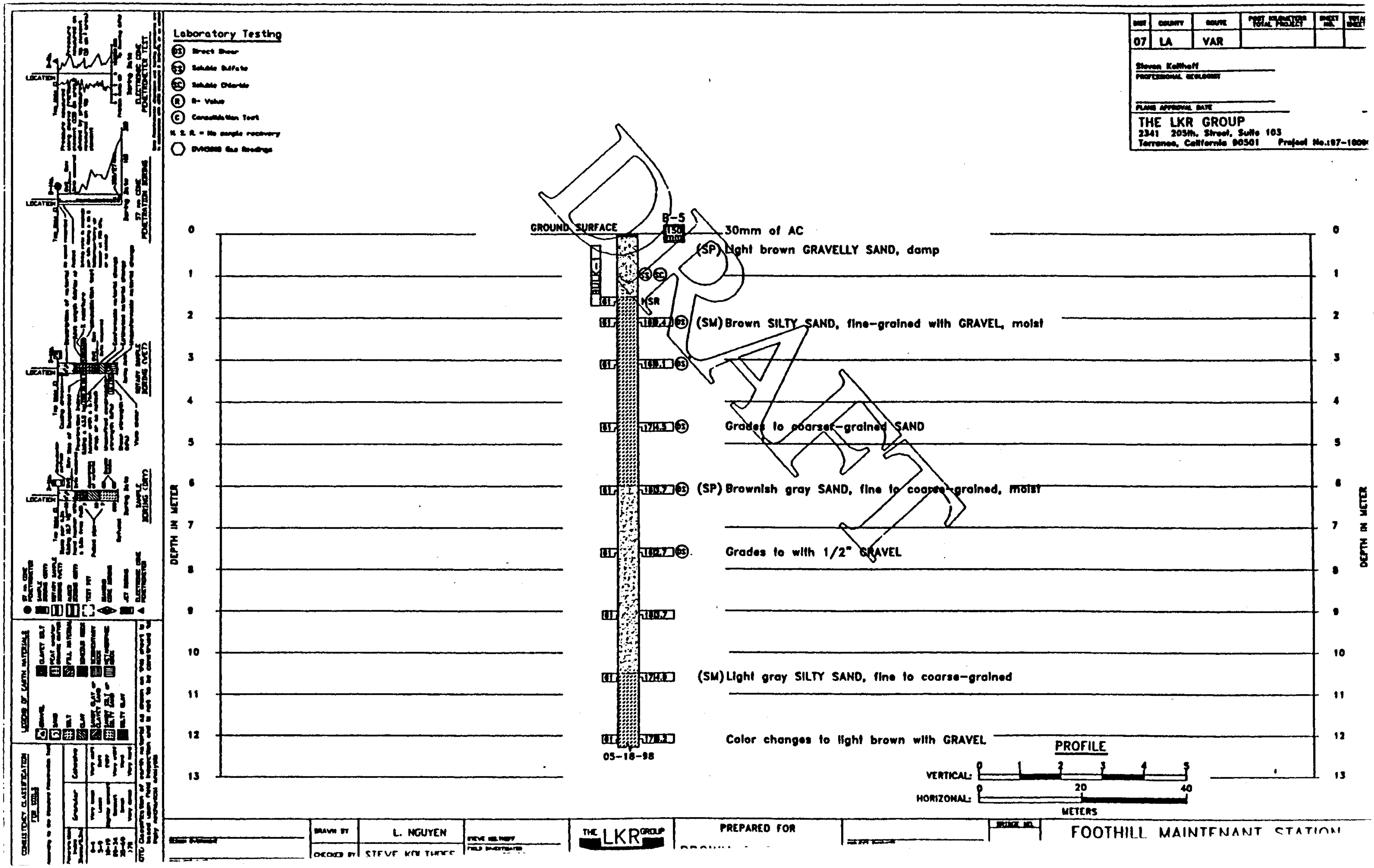
DRAWN BY	L. NGUYEN	STEVE KOLTHOFF	THE LKR GROUP	PREPARED FOR		BRIDGE NO.	TERMINATION PARK & RIDE
CHECKED BY	STEVE KOLTHOFF	FIELD INVESTIGATED 05-98		BROWN & CALDWELL		POST KILOMETER	LOG OF TEST BORINGS NO. 1



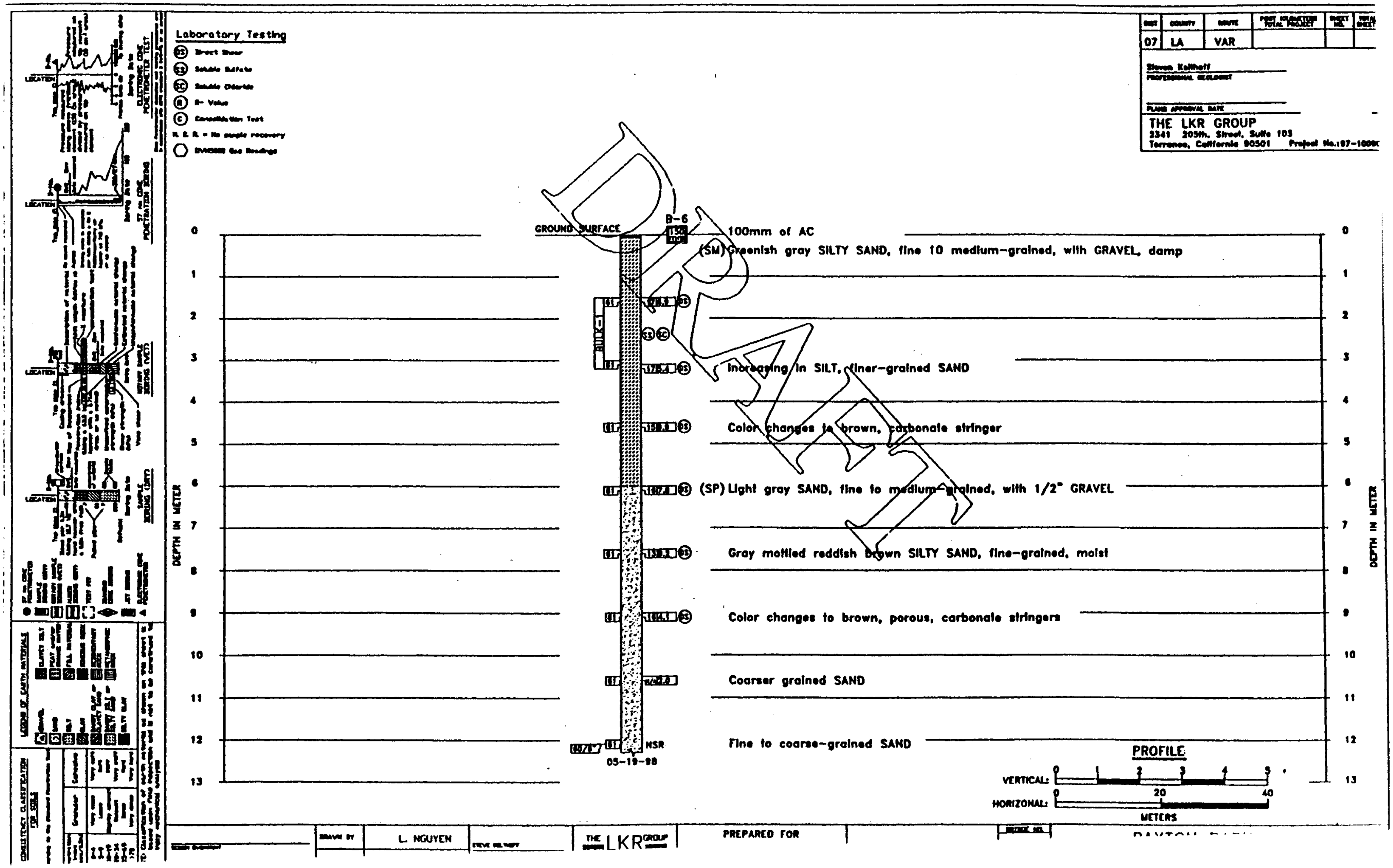
Laboratory Testing
DS Direct Shear
SS Soluble Sulfate
SC Soluble Chloride
R R- Value
C Consolidation Test
N. S. R. = No sample recovery
DVA/OVM Gas Readings
GROUND SURFACE
B-3
60mm of AC
200mm of Aggregate Base
(ML) Reddish brown SANDY SILT with CLAY, damp
BULK-1
NSR
(SP) Yellow to orange SAND, fine-grained, damp
(GP) Light gray SANDY GRAVEL
(SP) Light gray well-graded SAND with 1/2" GRAVEL
(SM) Gray mottled reddish brown SILTY SAND, fine-grained, moist
Dark gray mottled SILTSTONE-Puente Formation
05-18-98
DEPTH IN METER
PROFILE
VERTICAL:
HORIZONAL:
METERS
DRAFT
07
LA
VAR
Steven Kolthoff
PROFESSIONAL GEOLOGIST
PLANS APPROVAL DATE
THE LKR GROUP
2341 205th. Street, Suite 103
Torrance, California 90501
Project No.:97-1000C
DRAWN BY
L. NGUYEN
THE LKR GROUP
PREPARED FOR
BRIDGE NO.
EASTERN REGIONAL
LEGEND OF EARTH MATERIALS
CONSISTENCY CLASSIFICATION FOR SOILS



Laboratory Testing
DS Direct Shear
SS Soluble Sulfate
SC Soluble Chloride
R R- Value
C Consolidation Test
N. S. R. = No sample recovery
GROUND SURFACE
B-4
BULK-1
DEPTH IN METER
60mm of AC
200mm of Aggregate Base
(SP) Light brown GRAVELLY SAND, damp
(ML) Greenish gray SILT with SAND, moist
SANDSTONE & SILTSTONE gravels in SILTY CLAY matrix
(ML) Greenish gray SANDY SILT with CLAY
Fine to medium-grained lenses present
(CL) Brownish gray SANDY CLAY with SILT, moist
(SP) Blue-green SAND, fine to medium-grained, moist
Grades to with SLIT and organic matters
Greenish gray SANDSTONE, fine-grained, mottled reddish orange
Grades to with traces of SILT and CLAY
Color changes to yellowish orange
05-18-98
PROFILE
VERTICAL:
HORIZONAL:
METERS
DRAFT
07 LA VAR
Steven Kolthoff
PROFESSIONAL GEOLOGIST
PLANS APPROVAL DATE
THE LKR GROUP
2341 205th. Street, Suite 103
Torrance, California 90501
L. NGUYEN
STEVE KOLTHOFF
THE LKR GROUP
PREPARED FOR
VIA VERDE PARK

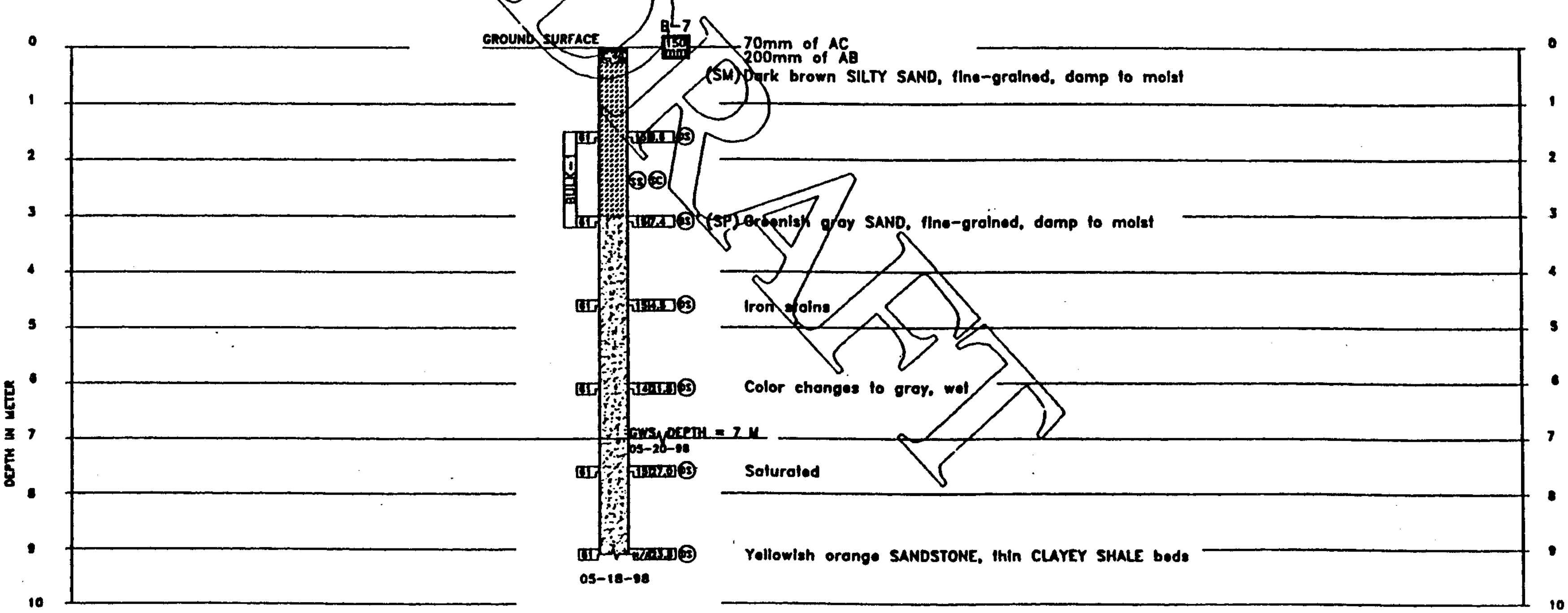


Laboratory Testing
N.S.R. = No sample recovery
DRAFT
GROUND SURFACE
B-5
30mm of AC
(SP) Light brown GRAVELLY SAND, damp
BULK-1
NSR
(SM) Brown SILTY SAND, fine-grained with GRAVEL, moist
Grades to coarser-grained SAND
(SP) Brownish gray SAND, fine to coarse-grained, moist
Grades to with 1/2" GRAVEL
(SM) Light gray SILTY SAND, fine to coarse-grained
Color changes to light brown with GRAVEL
05-18-98
DEPTH IN METER
PROFILE
VERTICAL:
HORIZONAL:
METERS
07
LA
VAR
Steven Kolthoff
PROFESSIONAL GEOLOGIST
PLANS APPROVAL DATE
THE LKR GROUP
2341 205th. Street, Suite 103
Torrance, California 90501
DRAWN BY
L. NGUYEN
CHECKED BY
STEVE KOLTHOFF
PREPARED FOR
FOOTHILL MAINTENANT STATION


Laboratory Testing
DS Direct Shear
SS Soluble Sulfate
SC Soluble Chloride
R R- Value
C Consolidation Test
N. S. R. = No sample recovery
THE LKR GROUP
2341 205th. Street, Suite 103
Torrance, California 90501
07 LA VAR
Steven Kolthoff
PROFESSIONAL GEOLOGIST
B-6
GROUND SURFACE
100mm of AC
(SM) Greenish gray SILTY SAND, fine 10 medium-grained, with GRAVEL, damp
Increasing in SILT, finer-grained SAND
Color changes to brown, carbonate stringer
(SP) Light gray SAND, fine to medium-grained, with 1/2" GRAVEL
Gray mottled reddish brown SILTY SAND, fine-grained, moist
Color changes to brown, porous, carbonate stringers
Coarser grained SAND
Fine to coarse-grained SAND
NSR
05-19-98
DEPTH IN METER
PROFILE
VERTICAL:
HORIZONAL:
METERS
DRAWN BY
L. NGUYEN
PREPARED FOR
DRAFT

Laboratory Testing

- (DS) Direct Shear
- (SS) Soluble Sulfate
- (SC) Soluble Chloride
- (R) R- Value
- (C) Consolidation Test
- N. S. R. = No sample recovery



PROFILE

VERTICAL: 0 1 2 3 4 5

HORIZONAL: 0 20 40

METERS

DIST	COUNTY	ROUTE	POST MILES TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
07	LA	VAR			

Steven Kolthoff
PROFESSIONAL GEOLOGIST

PLANS APPROVAL DATE

THE LKR GROUP
2341 205th. Street, Suite 103
Torrance, California 90501 Project No.197-1000C

DRAWN BY L. NGUYEN

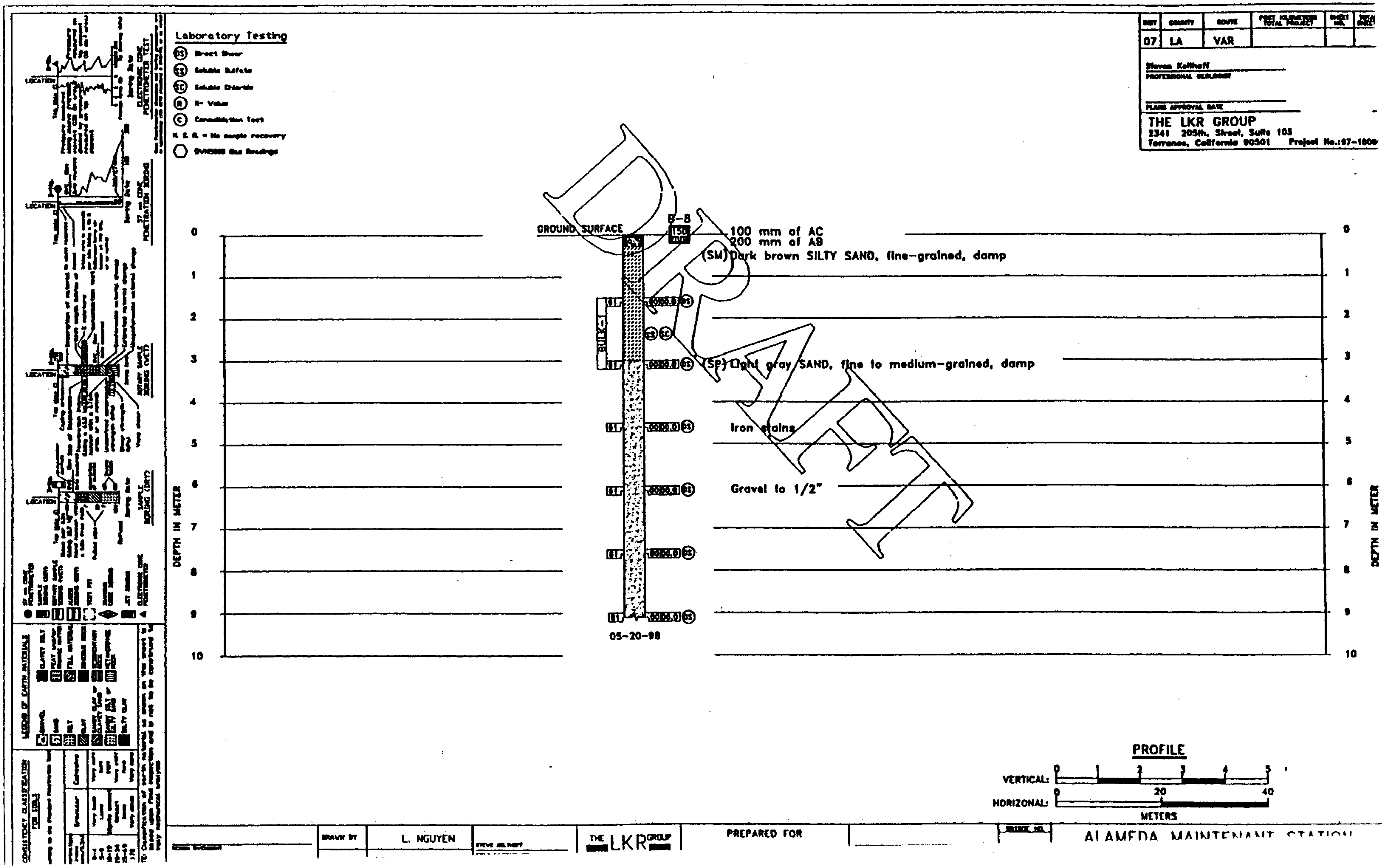
CHECKED BY STEVE KOLTHOFF

STEVE KOLTHOFF
FIELD INVESTIGATED

THE LKR GROUP

PREPARED FOR

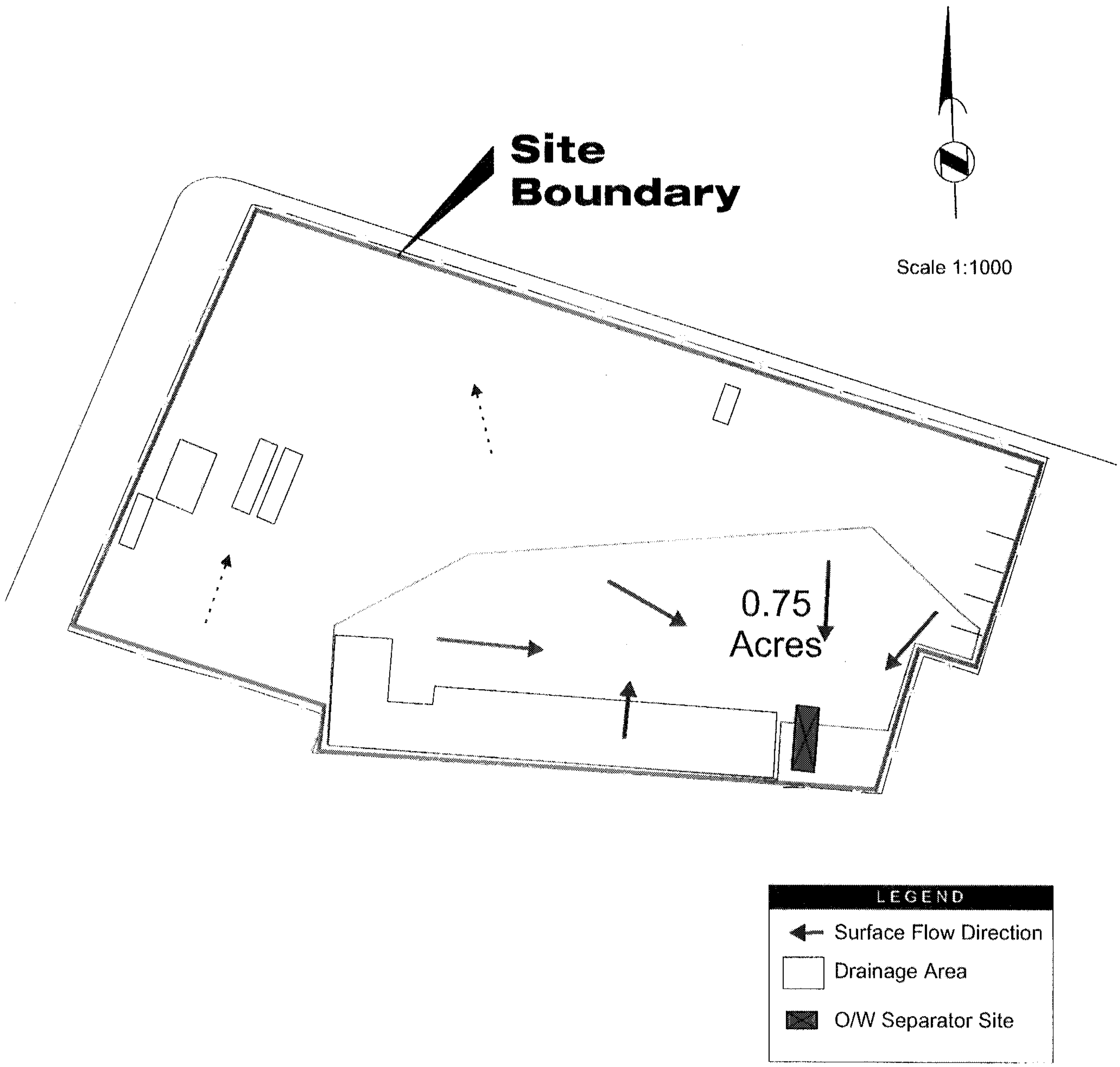
METRO MAINTENANT STATION



Laboratory Testing
DS Direct Shear
SS Soluble Sulfate
SC Soluble Chloride
R R- Value
C Consolidation Test
N. S. R. = No sample recovery
GROUND SURFACE
B-8
100 mm of AC
200 mm of AB
(SM) Dark brown SILTY SAND, fine-grained, damp
(SP) Light gray SAND, fine to medium-grained, damp
Iron stains
Gravel to 1/2"
BULK-1
05-20-98
DEPTH IN METER
0
1
2
3
4
5
6
7
8
9
10
DRAFT
07
LA
VAR
Steven Kolthoff
PROFESSIONAL GEOLOGIST
PLANS APPROVAL DATE
THE LKR GROUP
2341 205th. Street, Suite 103
Torrance, California 90501
PROFILE
VERTICAL:
HORIZONAL:
METERS
20
40
DRAWN BY
L. NGUYEN
THE LKR GROUP
PREPARED FOR
ALAMEDA MAINTENANT STATION

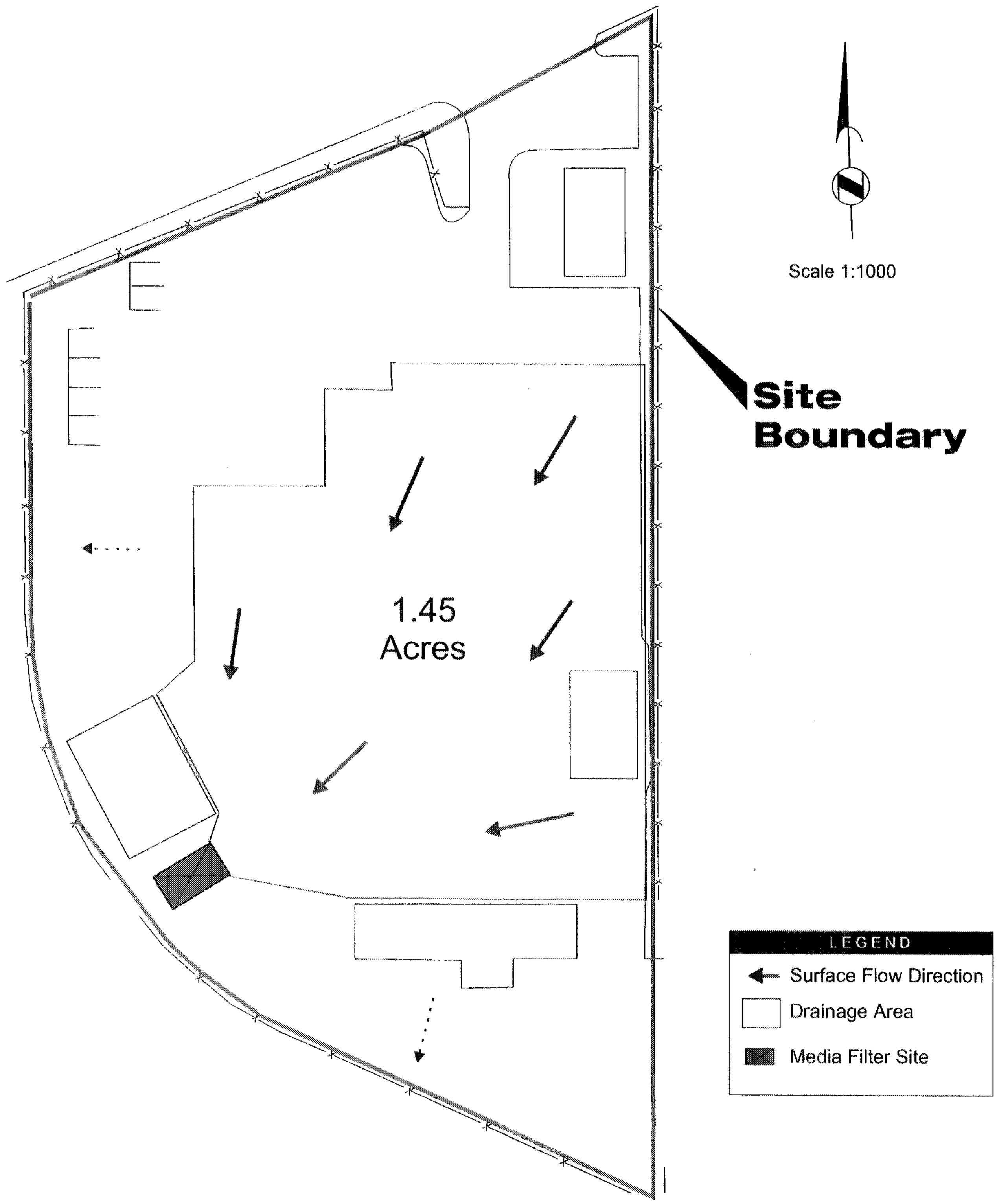
APPENDIX F

TREATMENT UNIT SITES DRAINAGE AREAS



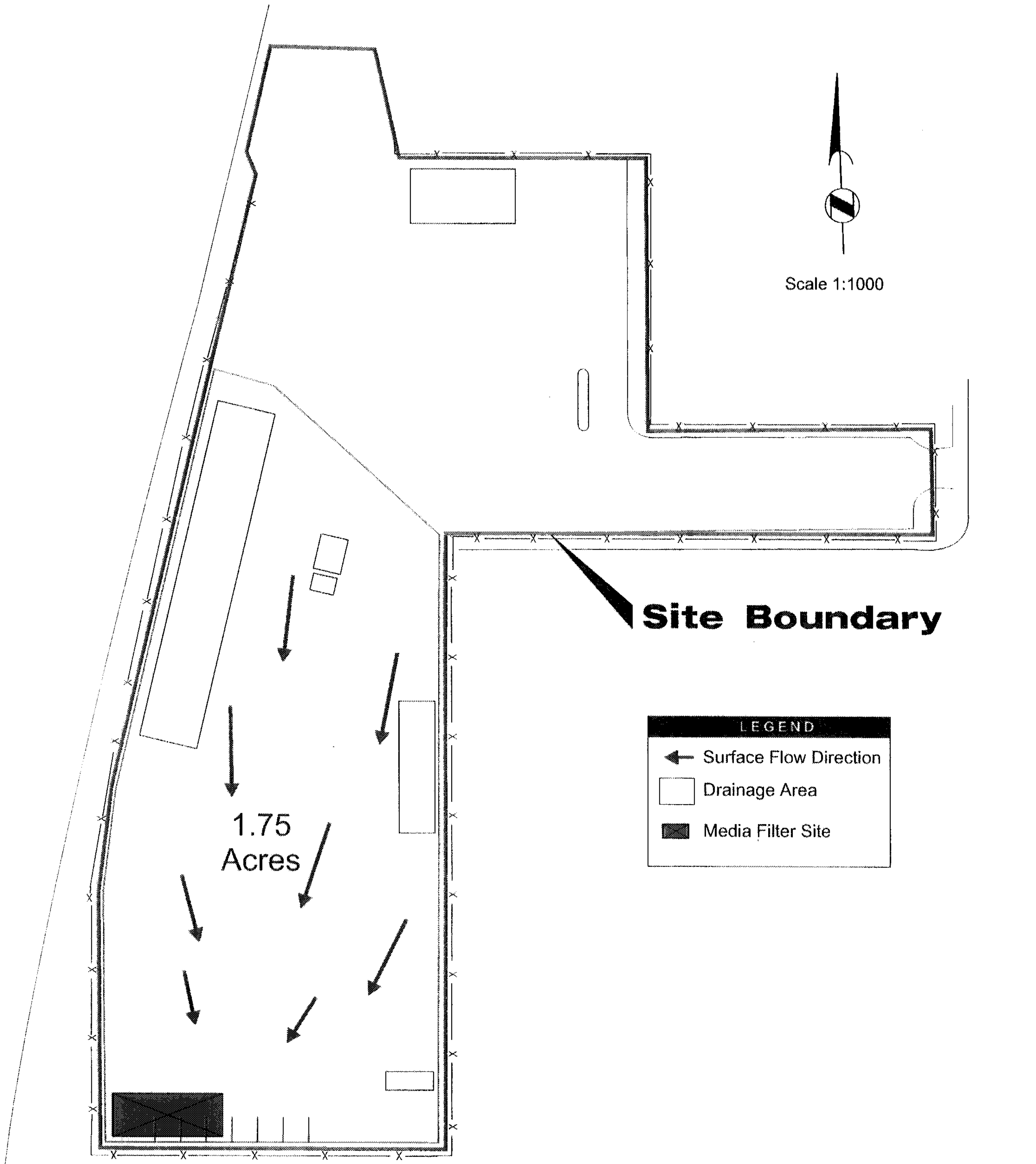
BROWN AND CALDWELL

Site 1 Alameda Maintenance Station
Drainage Area



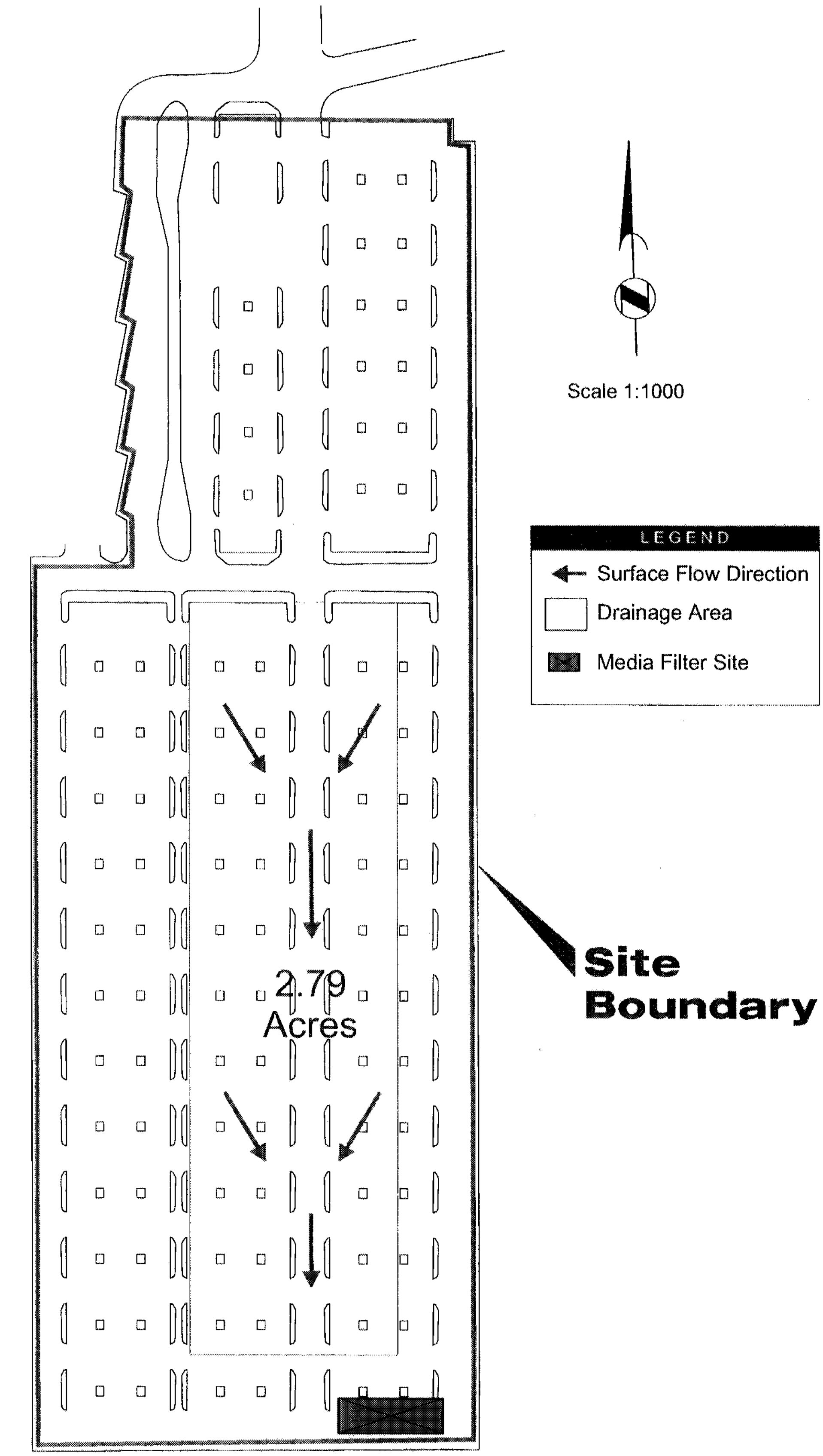
BROWN AND CALDWELL

Site 2 Eastern Regional Maintenance Yard Drainage Area



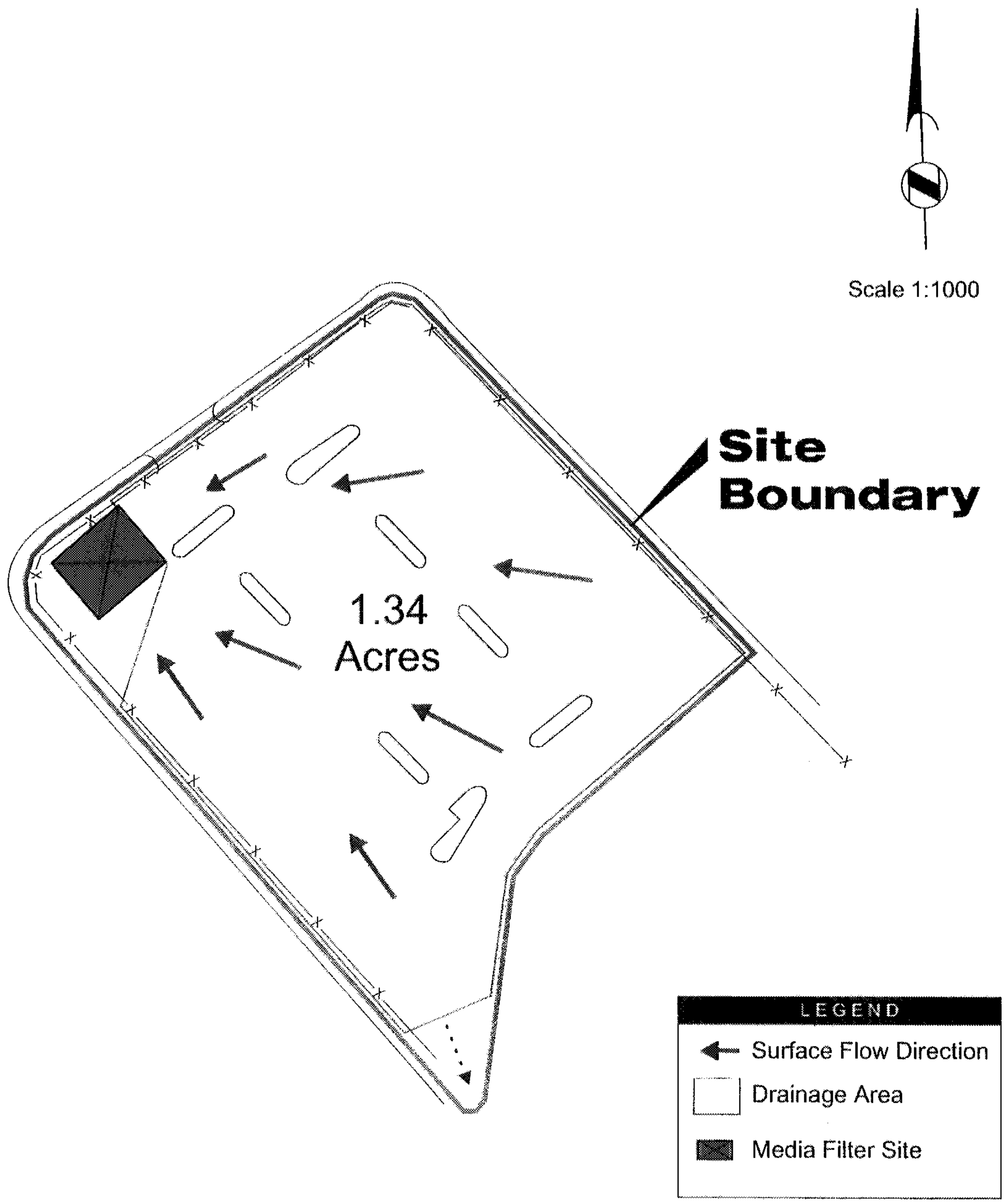
BROWN AND CALDWELL

Site 3 Foothill Maintenance Station Drainage Area



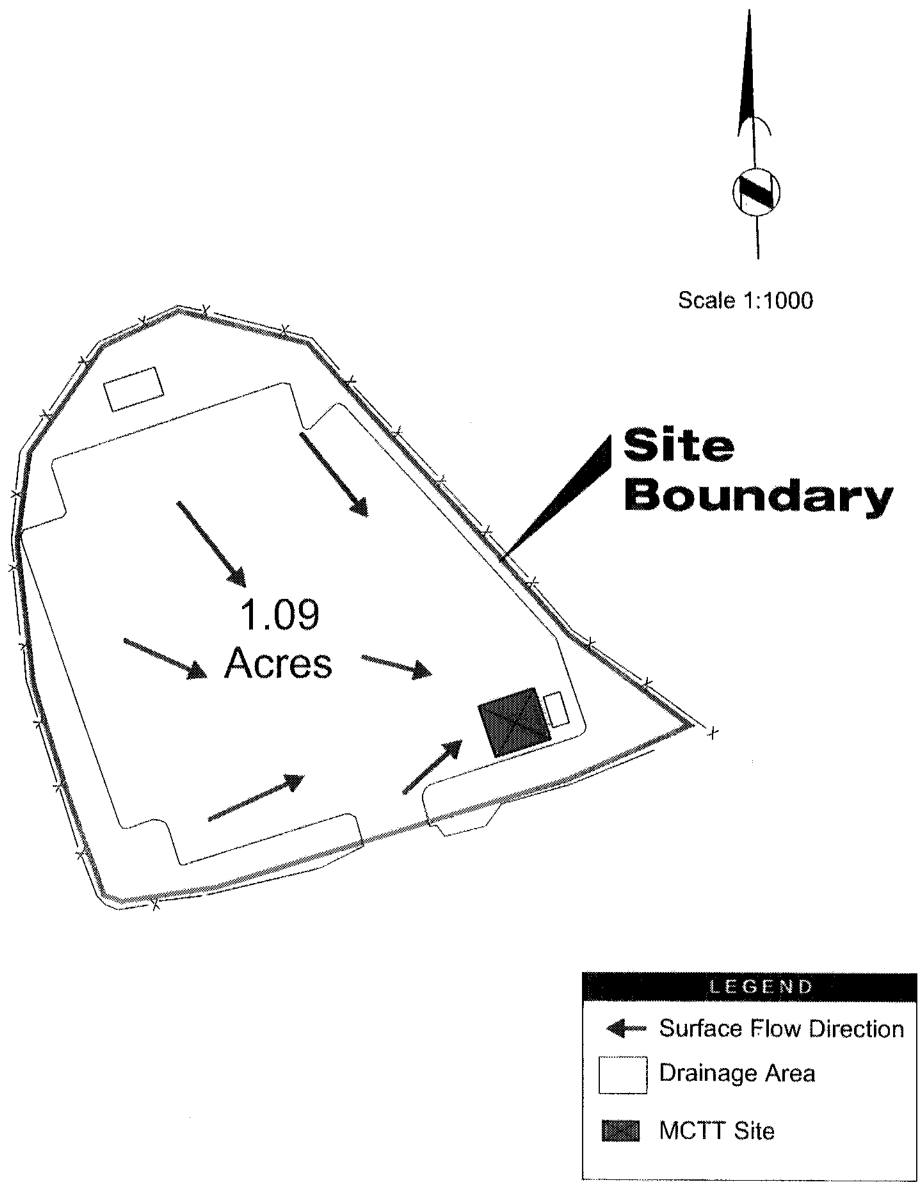
BROWN AND CALDWELL

Site 4 Termination Park & Ride
Drainage Area



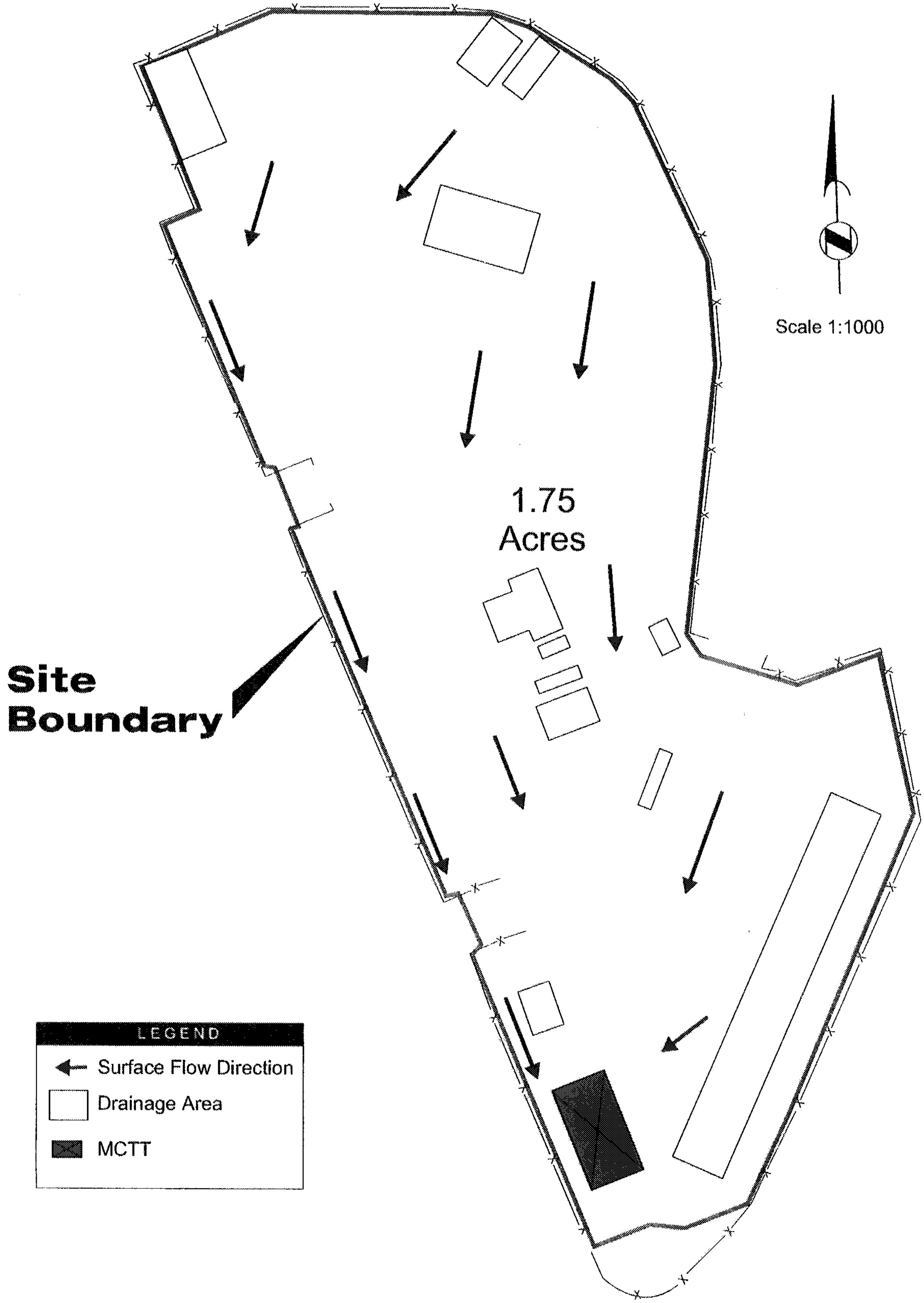
BROWN AND CALDWELL

Site 5 Paxton Park & Ride
Drainage Area

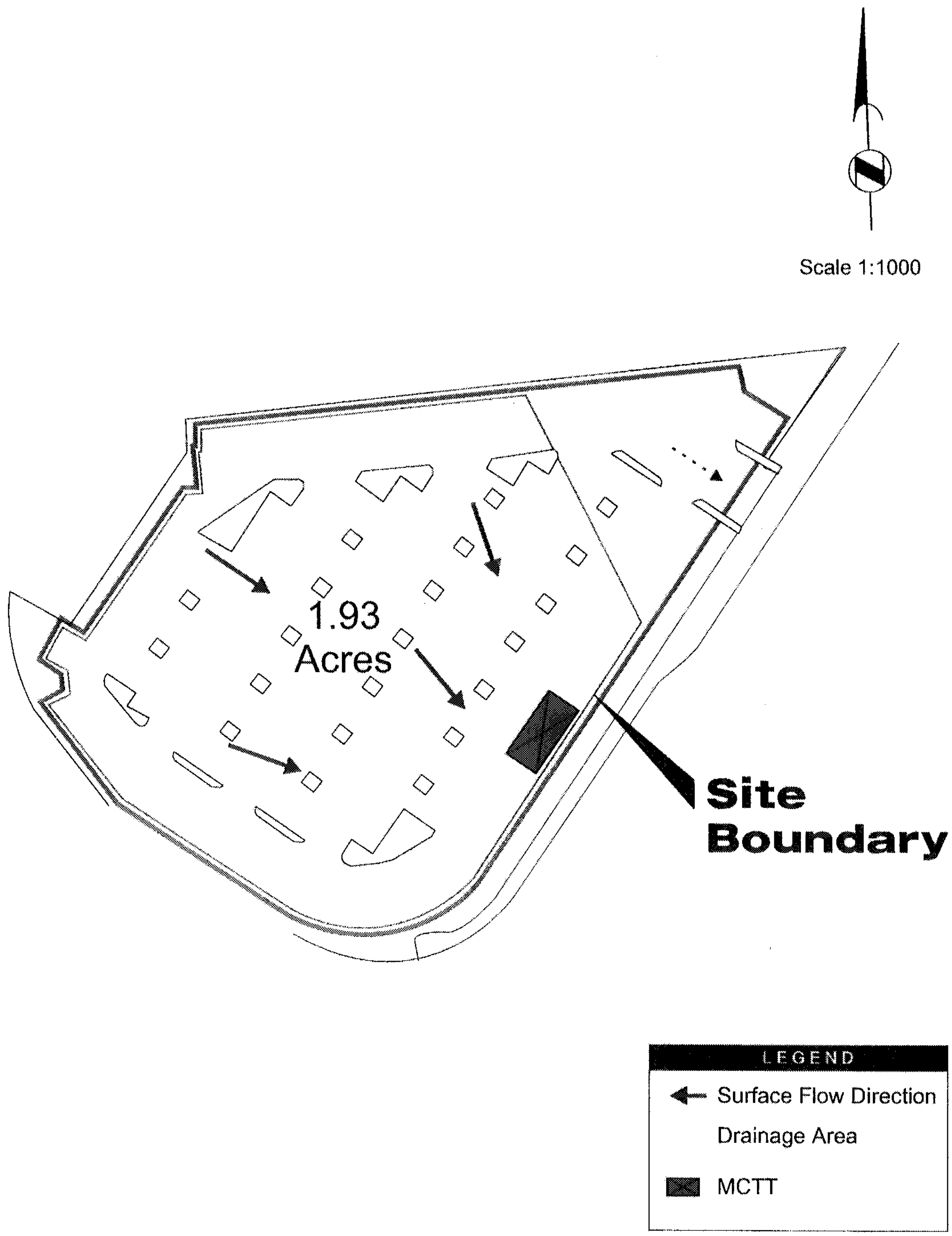


BROWN AND CALDWELL

Site 6 Via Verde Park & Ride
Drainage Area



BROWN AND CALDWELL	Site 7 Metro Maintenance Station Drainage Area



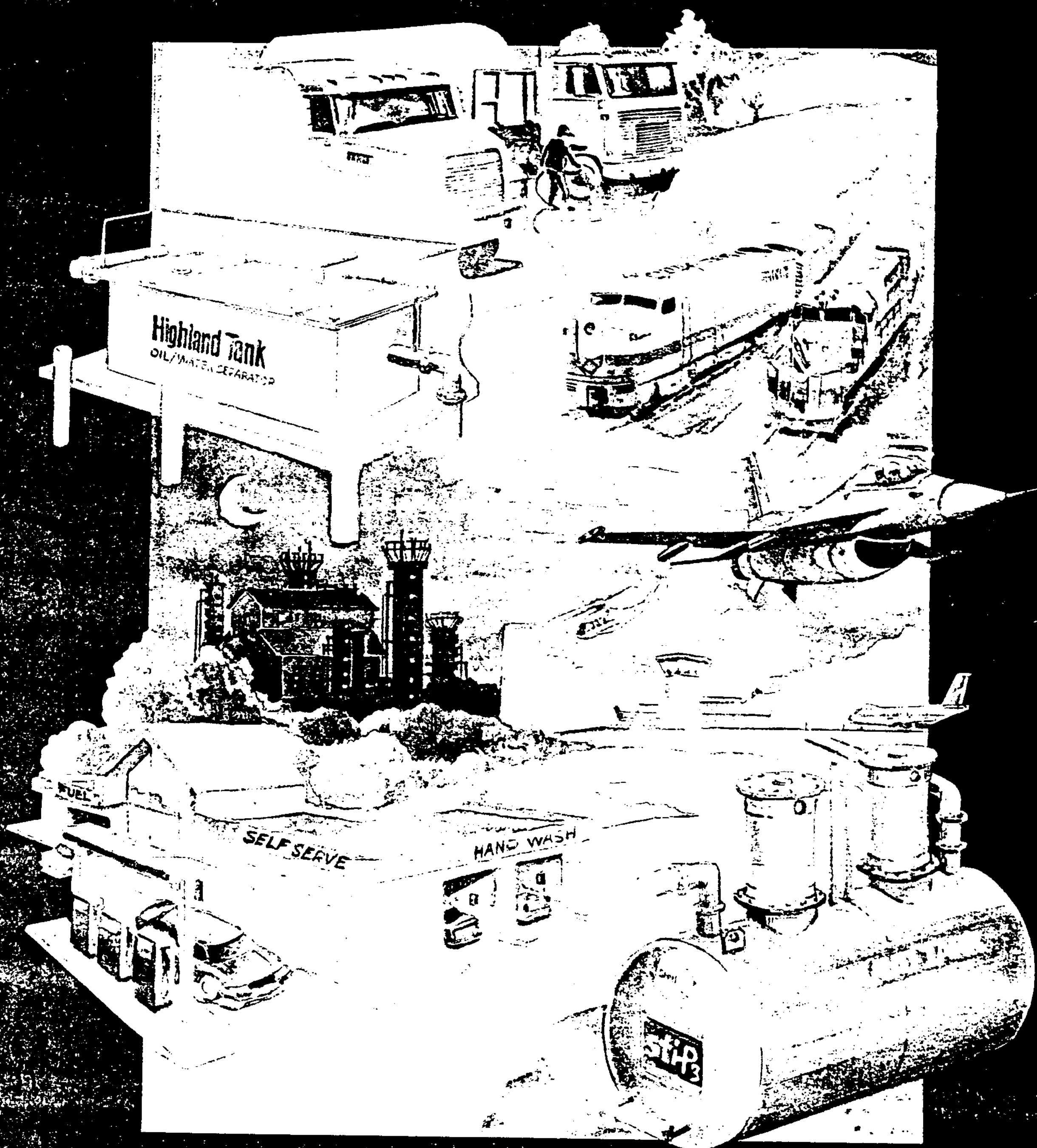
BROWN AND CALDWELL

Site 8 I-105/Lakewood Boulevard
Drainage Area

APPENDIX G

OIL/WATER SEPARATOR INFORMATION

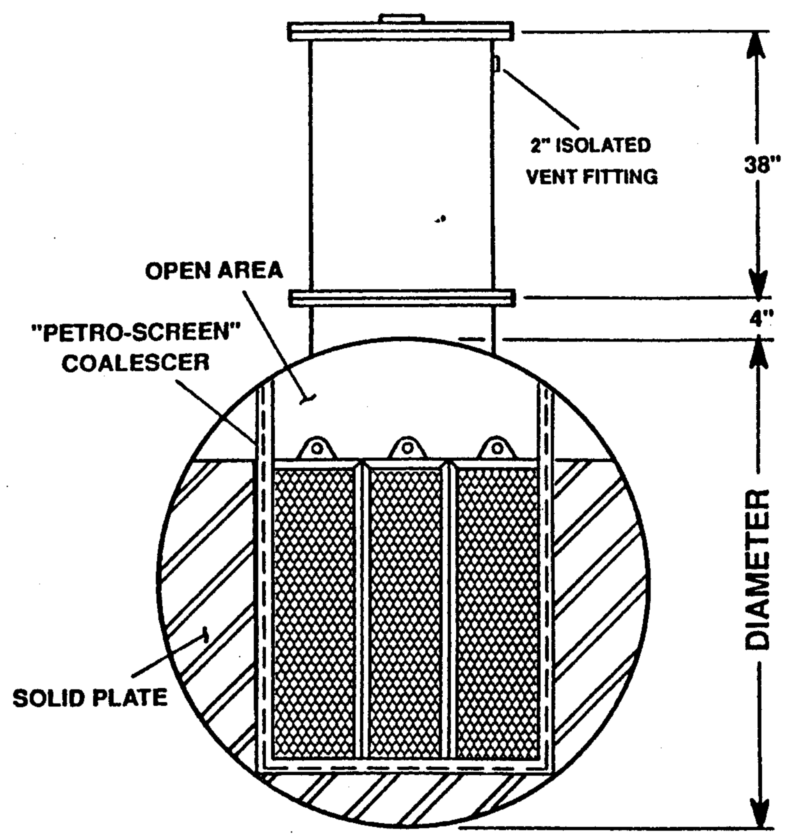
Oil/Water Separators and Interceptors



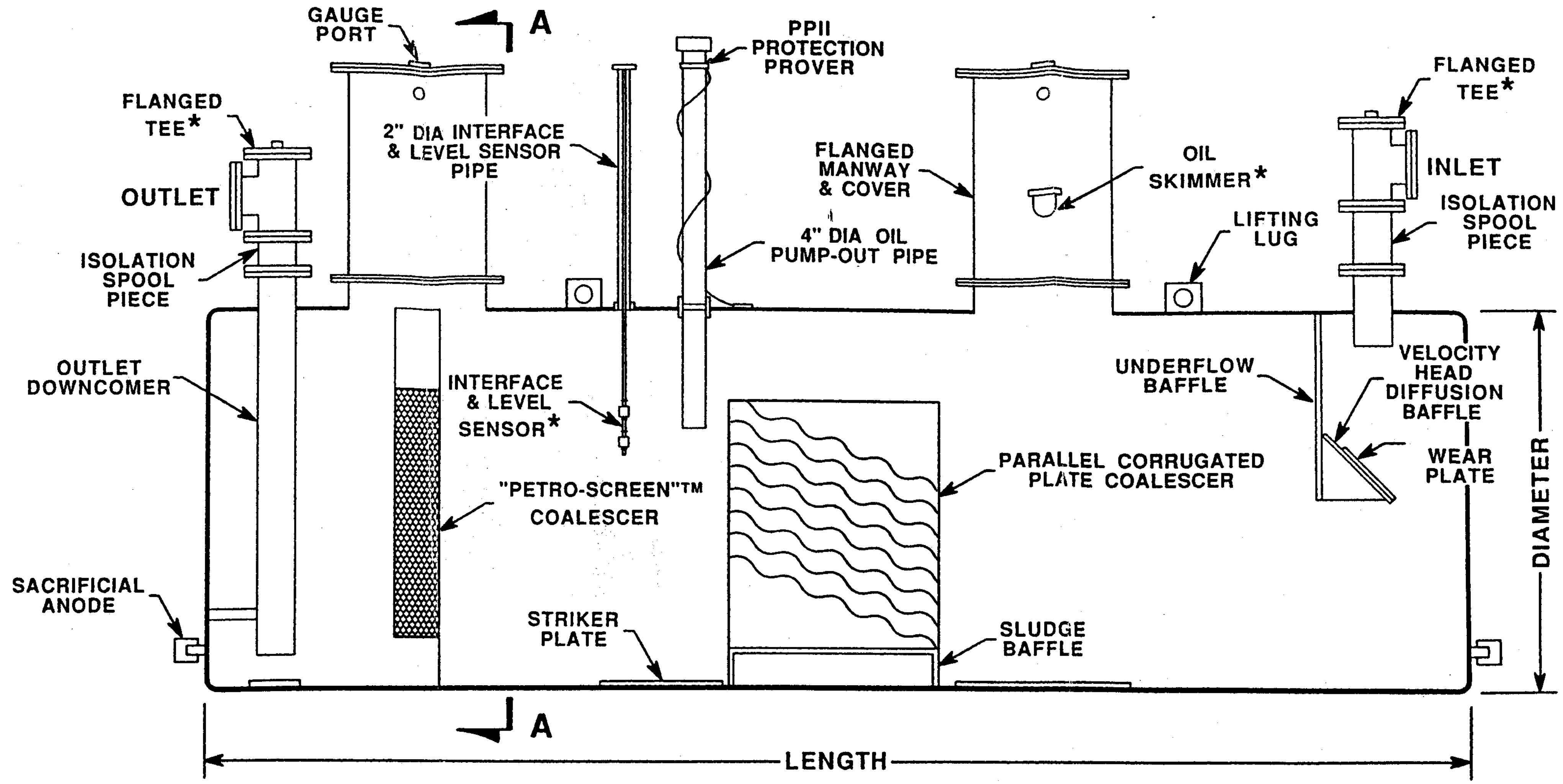
Working Together for a Cleaner Environment.

HIGHLAND TANK & MFG. CO.

Highland Tank



SECTION A - A



Schedule of Standard Size Oil Water Separator with Coalescer

Copyright 1992 By Highland Tank & Mfg. Co.

MODEL	TOTAL VOLUME	TOTAL SPILL CAPACITY	FLOW RATE	DIA.	LENGTH	INLET/ OUTLET	APPROX WEIGHT (LBS.)
HTC - 550	550	275	55	3' - 6"	7' - 9"	4"	2,024
HTC - 1,000	1,000	500	100	4' - 0"	10' - 9"	6"	3,001
HTC - 2,000	2,000	1,000	200	5' - 4"	12' - 0"	6"	4,122
HTC - 3,000	3,000	1,500	300	5' - 4"	18' - 0"	8"	5,001
HTC - 4,000	4,000	2,000	400	5' - 4"	24' - 0"	8"	5,760
HTC - 5,000	5,000	2,500	500	6' - 0"	23' - 10"	8"	8,082
HTC - 6,000	6,000	3,000	600	6' - 0"	28' - 8"	10"	9,484
HTC - 7,000	7,000	3,500	700	7' - 0"	24' - 4"	10"	11,124
HTC - 8,000	8,000	4,000	800	7' - 0"	28' - 0"	10"	11,959
HTC - 9,000	9,000	4,500	900	8' - 0"	24' - 0"	12"	11,983
HTC - 10,000	10,000	5,000	1,000	8' - 0"	26' - 8"	12"	12,696
HTC - 12,000	12,000	6,000	1,200	8' - 0"	32' - 0"	12"	14,131
HTC - 15,000	15,000	7,500	1,500	10' - 0"	25' - 6"	14"	19,567
HTC - 20,000	20,000	10,000	2,000	10' - 6"	31' - 0"	16"	23,316
HTC - 25,000	25,000	12,500	2,500	10' - 6"	38' - 9"	18"	30,546
HTC - 30,000	30,000	15,000	3,000	10' - 6"	46' - 6"	20"	35,586
HTC - 40,000	40,000	20,000	4,000	12' - 0"	47' - 3"	24"	44,389
HTC - 50,000	50,000	25,000	5,000	12' - 0"	59' - 0"	24"	51,511

GENERAL NOTES	ACCESSORIES FOR EACH SEPARATOR
Capacity in Gallons:	Double Wrap Shell: Type I or Type II
Number Required:	Hold Down Straps: Size -
Material:	Quantity -
Test:	Turnbuckles:
Gauge / Thickness: Heads -	Ladder:
Shell -	Level Sensor: A B C
Paint: Interior -	
Paint: Exterior -	
Construction: Flat Flanged Heads -	
Lap Weld - Outside Only	
(Unless otherwise noted)	
Special Notes: sti-P_3 is Standard	
	*LevelSensor, Alarm Box, Inlet and
	Outlet Tees and Oil Skimmer are
	Optional Equipment

Highland TANK & MFG. CO.
One Highland Road • Stoystown, PA 15563
Ph.: 814-893-5701 • FAX: 814-893-6126

Registered U.S. Patent Office
- U.S. Patent No. 4,722,800 -

Approved by the City of New York
Board of Standards and Appeals
under Calendar Number 1215-88-SA

Canadian Patent No. 1,296,263

Customer:

Order No.:

Project:

Scale	Drawn By	Date	Dwg. No.
NONE	SJM		

Highland Tank & Manufacturing Company
Oil/Water Separator Specifications
Model HTC

Provide and install _________ Highland Tank & Mfg. Co. Model HTC-______ parallel corrugated plate gravity displacement Oil Water Separator. Separator(s) shall be _________ in diameter, _________ long, having a total volume of _________ gallons.

1.0 Application

The separator shall be designed for gravity separation of free oils (hydrocarbons and other petroleum products) along with some settleable solids from water. The source of the influent to the separator shall be gravity flow from storm water runoff and spills.

2.0 Performance

2.1 Influent Characteristics

Provide Oil Water Separator designed for intermittent and variable flows of water, oil, or any combination of non-emulsified oil-water mixtures ranging from zero to _____ gpm. Operating temperatures of the influent oil in water mixture shall range from 40° F. to 180° F. The specific gravities of the oils at operating temperatures shall range from 0.68 to 0.95 and the petroleum hydrocarbon concentration less than or equal to 200,000 mg/l (20%). The specific gravity of the fresh water at operating temperatures shall range from 1.00 to 1.03.

2.2 Effluent Characteristics

The oil and grease concentration in the effluent from the oil water separator shall not exceed 10 mg/l (10 ppm). To achieve this goal, it will be necessary to remove all free oil droplets equal to and greater than 20 microns.

3.0 Design Criteria

3.1 The oil water separator shall be designed in accordance with Stokes Law and the American Petroleum Institute Manual on Disposal of Refinery Wastes, Volume on Liquid Wastes as stated in Chapter 5, Oil Water Separator Process Design and API Bulletin No. 1630 First Edition, Waste Water Handling and Treatment Manual for Petroleum Marketing Facilities.

The oil water separator shall comply with the following design criteria:

3.2 Capacities, dimensions, construction, and thickness shall be in strict accordance with Underwriters Laboratories, Subject UL-58 Standard for Safety, Steel Underground Tanks for Flammable and Combustible Liquids.

3.3 Corrosion Control System shall be in strict accordance with sti-P_3® specifications as applied by a licensee of the Steel Tank Institute. Manufacturer must be a licensee of Steel Tank Institute. No assigning or subcontracting of sti-P_3® licensing shall be permitted.

3.4 Separator shall be the standard product of a steel tank manufacturer regularly engaged in the production of such equipment. No subcontracting of tank fabrication shall be permitted.

3.5 Separator shall be fabricated, inspected and tested for leakage before shipment from the factory by manufacturer as a completely assembled vessel ready for installation. Inspection and test reports shall be supplied to customer on Manufacturer's letterhead.

3.6 Separator shall be cylindrical, horizontal, atmospheric-type steel vessel intended for the separation and storage of flammable and combustible liquids. The separator shall have the structural strength to withstand static and dynamic hydraulic loading while empty and during operating conditions.

3.7 Separator shall have an oil storage capacity equal to about 50% of the total vessel volume and an emergency oil spill capacity equal to 80% of the total vessel volume.

3.8 Separator shall consist of inlet and outlet connections, non-clogging flow distributor and energy dissipator device, stationary under flow baffle, presettling chamber for solids, sludge baffle, oil coalescing chamber with parallel corrugated plate and polypropylene coalescers to optimize separation of free oil from liquid carrier, effluent downcomer positioned to prevent discharge of free oil that has been separated from the carrier liquid, access for each chamber, lifting lugs, fittings for vent, oil pump out, sampling, and gauging.

4.0 General Description

The separator shall be a cylindrical parallel corrugated plate gravity displacement type oil water separator with construction and thickness in strict accordance with Underwriters Laboratories Subject 58, using flat flanged heads. The separator shall be a pre-packaged, pre-engineered, ready to install unit consisting of:

4.1 An influent connection __________ inch, flanged.

4.2 An internal influent nozzle at the inlet end of the separator, located at the furthest diagonal point from the effluent discharge opening.

4.3 A velocity head diffusion baffle at the inlet to:
- reduce horizontal velocity and flow turbulence.
- distribute the flow equally over the separators cross sectional area.
- direct the flow in a serpentine path in order to enhance hydraulic characteristics and fully utilize all separator volume.
- completely isolate all inlet turbulence from the separation chamber.

4.4 A sediment chamber to disperse flow and collect oily solids and sediments.

4.5 A sludge baffle to retain settleable solids and sediment and prevent them from entering the separation chamber.

4.6 An Oil Water Separation Chamber containing a parallel corrugated plate coalescer to:
- shorten the vertical distance than an oil globule has to rise for effective removal.
- enhance coalescence by generating a slight sinusoidal (wave like) flow pattern thereby causing smaller, slow rising, oil globules to coalesce on the undersides of the plates forming larger, rapidly rising sheets of oil.
- direct the paths of the separated oil to the surface of the separator.

4.7 An Oil Water Separation Chamber containing a removable "PETRO-SCREEN™ polypropylene coalescer designed to intercept oil globules equal to and greater than 20 microns in diameter to produce an effluent quality of 10 ppm oil and grease.

4.8 An internal effluent downcomer at the outlet end of the separator, to allow for discharge from the bottom of the separation chamber only.

4.9 An effluent connection __________ inch, flanged.

4.10 Fittings for vent, interface/level sensor, and waste oil pump out, sampling, and gauge.

4.11 Two 24" diameter UL-approved, manholes (18" on 550 gallon), complete with __________ ft. extensions, cover, gasket, and bolts. One manway shall be placed between the inlet and the parallel corrugated plate coalescer to facilitate access into the sediment chamber for solids removal. One manway shall be placed between the parallel corrugated plate coalescer and outlet to facilitate access into the oil water separation chamber for oil removal.

4.12 Lifting lugs at balancing points for handling and installation.

4.13 Identification plates: Plates to be affixed in prominent location and be durable and legible throughout equipment life.

4.14 sti-P_3® Corrosion Protection System consisting of:
- Isolation spool pieces
- Dielectric isolation gaskets and bushings
- External surfaces commercially sand-blasted and coated 10 mils on shell, 15 mils on head, DFT Polyurethane or 60, 100 or 125 mils head and shell, Fiberglass Reinforced Polyester
- Cathodic protection system using zinc anodes
- PPII Protection Prover
- sti-P_3® Limited 30-year Warranty: Thirty year protection against external corrosion and structural defects.

4.15 Internal surfaces commercially sand-blasted, coated 15 mils DFT Polyurethane

5.0 Construction And Materials

Refer to U.L. 58 and sti-P_3® Specifications.

6.0 Quality Assurance

6.1 Submittals:
- Shop Drawings: for oil water separators shall show principal dimensions and location of all fittings.
- Provide three complete sets of installation, operation, and maintenance instructions with separator.
- Quality control and inspection procedures and reports shall be considered of the submittal package.

6.2 Warranty

• The manufacturer shall warrant its products to be free from defects in material and workmanship for a period of one year from the date of shipment. The warranty shall be limited to repair or replacement of the defective part(s). sti-P3 Limited Warranty: Lifetime protection for structural defects. Thirty year protection against external corrosion and structural defects.

7.0 Approved Manufactures

The Oil Water Separator shall be manufactured by Highland Tank and Mfg. Co., One Highland Road, Stoystown, PA 15563, Phone (814) 893-5701, Facsimile 814-893-6126.

8.0 Accessories

8.1 Separator furnished with intrinsically safe oil level controls to activate high level alarm at a predetermined oil level. All components enclosed in NEMA ______________ enclosure.

8.2 Separator furnished with oil level/liquid level controls to start and stop oil pump and to activate high level alarm at predetermined levels. All components enclosed in NEMA __________ enclosure.

8.3 Separator furnished with bucket type oil skimmers which can be manually adjusted to drain off precisely the amount of oil desired, to a separate waste oil tank.

8.4 A Highland Tank & Mfg. Co. Waste Oil Storage Tank for separated oil. Tank capacity shall be __________ gallons. Tank shall be __________ in diameter and __________ long. Construction and thickness of tank shall be in strict conformance with Underwriters Laboratories Subject 58, using flat flanged heads. The corrosion control system shall be in strict accordance with sti P-3 specifications as applied by a licensee of the Steel Tank Institute.

8.5 Consult Manufacturer for:

• Special coating (interior or exterior)

1. Polyurethane
2. Fiberglass Reinforced Polyester
3. Coal Tar Epoxy
4. Primer
5. Enamel
6. Vinyl
7. Epoxy Phenolic
8. Epoxy Polyamide Combination

• Aboveground Skids

• Pump Out Systems with integral compartment sumps:

1. Oil Pump Out
2. Water Pump Out
3. Sludge Pump Out

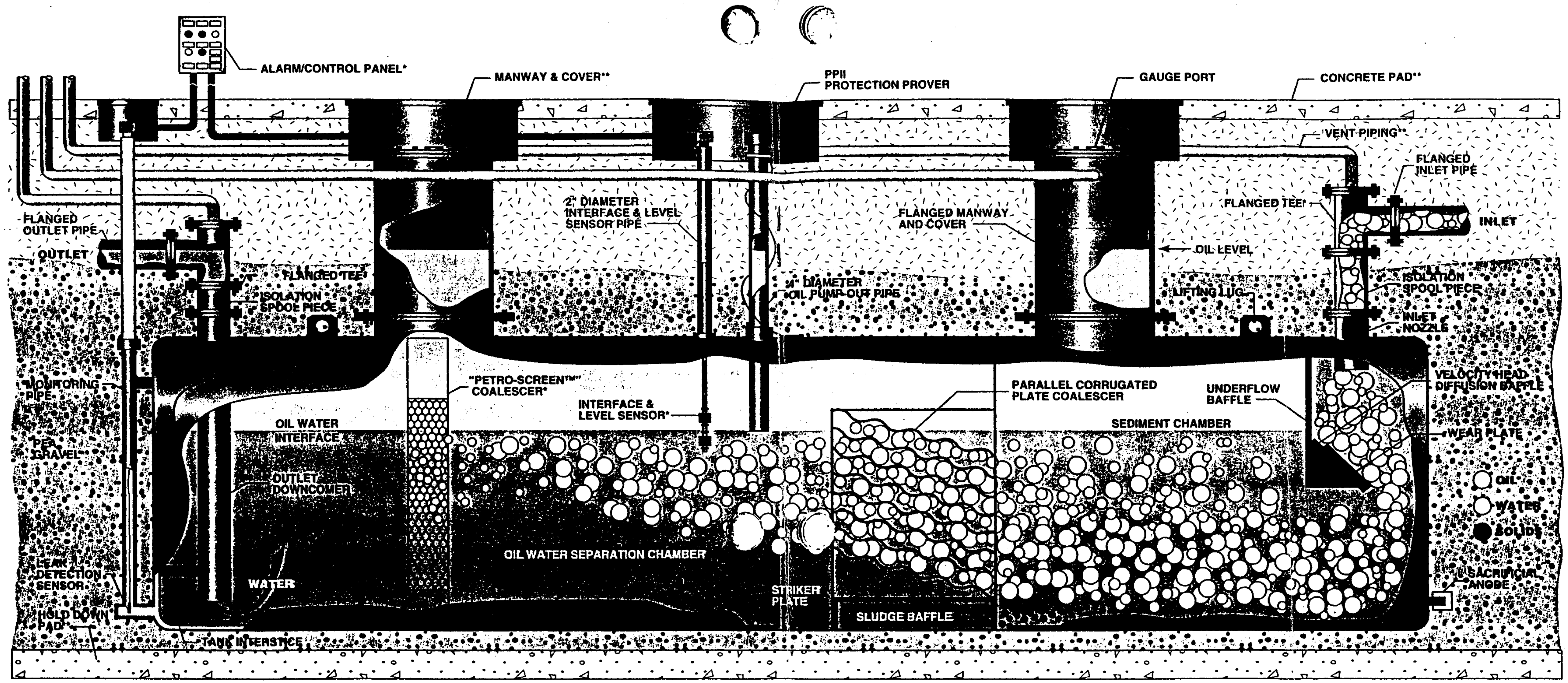
• Level Controls

• Heating Systems

1. Electric
2. Steam

• Tank Accessories: Refer to Highland Tank Catalog

How It Works . . .



* Optional equipment available from Highland Tank ** Installer supplied equipment

Highland's Patented Design

Highland Tank's patented design combines state-of-the-art technology with time-tested materials, making Highland separators the strongest and most reliable high-performance separators in the industry.

The oil/water separator is a stationary underground, wastewater treatment vessel, filled with water. Internal baffles and coalescers accelerate the oil/water separation process. Waste accumulates within the separator while effluent is discharged by gravity.

Diffusion Baffle

The velocity head diffusion baffle, located near the inlet of the separator, is designed to serve four basic functions:

1. *To dissipate the velocity head, thereby improving the overall hydraulic characteristics of the separator.*
2. *To direct incoming flow downward and outward maximizing the use of the separator volume.*
3. *To reduce flow turbulence and to distribute the flow evenly over the separator's cross-sectional area.*
4. *To isolate inlet turbulence from the rest of the separator.*

Internal Chambers

In the sediment chamber, heavy solids settle out, and concentrated oil slugs rise to the surface. As the oily water passes through the parallel corrugated plate coalescer (an inclined arrangement of parallel corrugated plates) the oil rises and coalesces into sheets on the underside of each plate. The oil then creeps up the plate surface, and breaks loose at the top in the form of large globules. These globules then rise rapidly to the surface of the separation chamber where the separated oil accumulates.

The effluent flows downward to the outlet downcomer, where it is discharged by gravity displacement from the lower regions of the separator.

Petro-Screen™

For enhanced oil removal efficiency, a "Petro-Screen™" polypropylene coalescer (a bundle of oleophilic [oil attracting] fibers, layered from coarse to fine and encased within a solid framework) is used to intercept droplets of oil too minute to be removed by the parallel corrugated plate coalescer.

Monitoring Systems

For easy and efficient operation and maintenance, an oil level sensor can sound an alarm at high oil levels so waste oil can be removed from the separator. Double-wall separators can be furnished with a leak detection system for the interstitial space.

Additional monitoring equipment is available for oil or water level sensing, alarm and pumpout control.

APPENDIX H

MCTT REVIEW COMMENTS

R. Pitt
May 13, 1998

COMMENTS ON MAY 11, 1989 SITE VISIT AND REVIEW OF MCTT DESIGNS

General Comments

• The MCTT sizes appear to be reasonable for the locations. A continuous simulation of the main settling chamber performance was conducted using a series of 112 LAX rains for 1983 through 1985. 1983 had 28.4 inches of rain, over 64 separate events, while 1984 only had 7.4 inches of rain and 23 events and 1985 had 9.1 inches of rain and 28 events. The long-period average rain depth for LAX is 14.9 inches, which was close to the average of these three years. Southern California is known for extreme variations in rain conditions, and this modeling evaluation was therefore important to evaluate the range of conditions represented by these three years.

• The most efficient hydraulic resident time in the main settling chamber is 48 hours and the expected runoff volume captured in that chamber ranges from 0.45 to 0.52 inches of runoff for this rain series for the three installations.

• In all three installations, the average performance for these three rain years is expected to be greater than 80% control for suspended solids, toxicity (indicated using Microtox®), lead, zinc and for most organic toxicants (such as fluoranthene, pyrene, pentachlorophenol, and phenol). Volatile suspended solids, COD, and unfiltered heavy metals should be controlled at levels of about 60%. Excessively wet years would have reduced performance, while drier years would have better performance (increases and decreases in annual average performance of about ±10% may be expected).

• The filtration/ion exchange/sorption chambers are also appropriately sized for the site conditions (having about 3 m/d filtration rates). The flow rates through the media are suitable, and the expected life of the media before clogging may occur is expected to be from 3 to 5 years.

Suggestions

• The ion exchange/sorption media should be a mixture of 50% sand and 50% peat, not just sand alone. This layer should be about 12 inches thick, on top of a 6 inch layer of sand. This should be on top of a filter fabric layer, separating the underdrainage layer. The top of the media should be covered by a filter fabric layer (recommend the Amoco 4557) to act as a flow distributor, to sorb small quantities of oil, and to attract fine particles that are discharged from the main settling chamber.

• The main settling chamber should have a small sump pit installed (possibly several feet across and deep) to assist in cleaning out the captured sediment. This may make cleaning the sediment from the MCTT easier by allowing the sediment to be washed towards this sump where it could be removed during the infrequent cleanings.

• It may be more suitable to pump the water from the main settling chamber to the final ion exchange/sorption chamber, instead of relying on the very small orifices that would otherwise be needed. If orifices are used, then special care would be needed to prevent clogging. A relatively large cage could be constructed around the orifice plate, with many holes slightly smaller than the orifice itself. In all cases, the orifice (or pump) should be easily accessible for inspection and cleaning.

Even though we have only experienced minimal clogging problems with the orifices in the existing full-size MCTT units currently in operation, it is expected that small pumps would provide better control and more reliable performance. The required pump capacities would be very small and would therefore be inexpensive. They could be automatically activated after several inches of water accumulates in the main settling chamber, above the inclined tubes. The pumps would be automatically shut off when the water level dropped to the top of the inclined tubes. The following table shows the approximate necessary pumping rates, average orifice flows, and orifice diameters that would be needed for the three installations:

	Approx. Pumping Rate	Comparable Average Orifice Discharge	Approximate Orifice size (diameter, in.)	Stor cap.
Via Verde Park and Ride	280 gal/min .62 cfs.	0.01 cfs	0.3 8 hrs.	1780 cf
Metro maintenance yard	1170 gal/min 2.61 cfs.	0.04 cfs	0.6 1 hrs.	7480
Lakewood Blvd. Park and Ride	490 gal/min 1.09 cfs.	0.02 cfs	0.5	3150.

• Floating sorption sock/pillows should be placed in the main settling chamber.

$$1780\ ft^3 \times \frac{1}{0.62\ \frac{ft^3}{s}} \times \frac{1\ min}{60\ s} \times \frac{hr.}{60\ min}$$

• For uncovered MCTT units, bypassing flows (after the main settling chamber is full) should be diverted around the last chamber to prevent scouring of the media and other damage. Extend the concrete walls above the pavement surface by about 6 inches, for example, and have another inlet (above the catchbasin inlet elevation, but below this extended wall elevation) for this excessive water to re-enter the drainage system.

• A general inspection should be made of the MCTTs every 6 months, or so. It may be necessary to clean the catchbasin inlet and to replace the sorption sock/pillows at this interval. A general inspection of the whole unit should be conducted at this interval to indicate the accumulation rate of material in the main settling chamber and to check the condition of the top filter fabric in the last chamber.

- The catchbasin sumps need to be at least 1 m below the hooded outlets. If the sumps were deeper, less frequent cleaning would be needed.

- The inlet to the main settling chamber from the catchbasin should terminate with a perforated flow distributor running across the tank.

- At all three sites, evaluate ways to decrease the installation depths of the MCTT units. One way may be to only monitor flow at the discharge from the MCTTs, while also monitoring water elevations in the main settling chamber and in the final sorption/ion exchange chamber. This information will enable the "before storm" conditions to be known and to also enable flow-weighted composite sampling. This may enable the units to be elevated by about 1 m, reducing site installation problems. However, the extra storage volume eliminated will slightly decrease the MCTT performance during the extreme rains (this extra benefit was not included in the modeling evaluations reported above).

- At the Metro maintenance yard, replace the stripping column balls in the inlet chamber with an adverse sloped inclined screen to minimize clogging problems associated with the vegetation at this site.

- The MCTT units at Lakewood and Via Verde may be shifted slightly to allow water to enter the catchbasin inlet of the MCTT directly through a surface grating (assuming that flows would be monitored at the MCTT discharge and that water levels in the MCTT would be monitored, as listed above). This would significantly reduce the project foot prints at these locations, and possibly enable the units to be elevated.